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NOTICE TO AUTHORS OF PAPERS

1. **Forwarding Address.** Papers intended for publication in THIS JOURNAL should be submitted to Neil E. Gordon, Editor, The Johns Hopkins University, Baltimore, Maryland.

2. **Manuscript.** The manuscript submitted should be an original (not a carbon) copy, and typewritten, double-spaced, with 2–3 cm. margins. The title of the article should be followed by the name and address of the author. If the paper has been presented at a meeting, a footnote giving name of society, date, and occasion should immediately follow the author's name. The usual editorial customs, as exemplified in the most recent issues of the JOURNAL, should be followed as closely as possible.

3. **References and Footnotes.** Each reference to the literature and each footnote should be inserted without a number, as a separate line (or lines) immediately following the word to which it refers in the text. A reference to literature should include, in the order named, the title of book or article, author's name, edition or volume, pages, date of publication, and, in the case of books, publisher's name.

4. **Illustrations.** Not all articles lend themselves to illustrations, but articles which do should be accompanied by as many pertinent illustrations as possible. As a rule, apparatus, particularly if complicated, is best presented by means of line or working drawings. Photographs are sometimes sufficient, however. When both can be obtained, it is generally desirable to include both.

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BERTRAM BORDEN BOLTWOOD
1870–1927

EDITOR'S OUTLOOK

WHEN we consider the literature already available on radioactivity, we are forcibly impressed by the steady and rapid advance of scientific investigation, for this property of matter was discovered by Henri Becquerel as recently as 1896. And one who was a substantial and invaluable contributor to this vast accumulation of data was Bertram Borden Boltwood, whose portrait (for which we are indebted to members of the Chemistry Department of Yale University) appears on the opposite page.

Bertram Borden Boltwood

His wide acquaintance with fields extraneous to his science is not surprising in the light of his cosmopolitan training. He studied abroad with such men as Krüss at the Ludwig-Maximilian University of Munich, Ostwald at Leipsig, and Rutherford at the University of Manchester. His activity in this country was always closely associated with Yale University, as he graduated from the Sheffield Scientific School in 1892, received his Ph.D. in 1897, and creditably held various teaching and administrative positions in both the physics and chemistry departments.

Boltwood early interested himself in the improvement of laboratory technic and apparatus, a hobby which was of inestimable value throughout his career. Professor Alois F. Kovarik[1] commenting upon this states:

"The time and energy spent in gathering all sorts of information on laboratory arts and technic was well spent as judged not only by the benefit derived in the useful applications in his own work in later years, but also by the results shown by his guidance given to research students in the Sloane Physics Laboratory as well as in the Kent and the Sterling Chemistry Laboratories at Yale. Every one consulting him was certain to receive definite assistance and all who were privileged to associate with him found him to be a veritable storehouse of information on laboratory arts. He also contributed to these arts. For example, when a wax of low melting point was desired he found a way of producing it and the "Boltwax" was for a long time a much desired wax in many laboratories of this country. In later years he conducted regular demonstration classes in laboratory for research students in physics and chemistry, better to fit these students to solve their difficulties in the technic concerned in their researches."

Viewed from the point of scientific achievement, the years 1900–10 comprise the most important period of Boltwood's life. His experimental investigations were carried out in his private laboratory in New Haven during the early part of this period, while later work emanated from the

[1] *Am. J. Sci.*, **15**, 189–98 (Mar., 1928).

Sloane Physics Laboratory. As is often the case, the realization of the full significance of his researches was not always coincident with the publication of his newly discovered facts. A complete bibliography of Boltwood's published work can be found in the article previously mentioned. We can but indicate here his outstanding contributions to the development of radioactivity:

1. Discovery of a chemical element, ionium, the parent substance of radium.
2. Proof of the genetic relation of uranium, ionium, and radium.
3. Demonstration of the chemical inseparability of certain elements with identical chemical properties, a fact which formed for many chemists and physicists the starting-point of observations leading to isotopy.
4. Evidence that "lead" found in uranium minerals must be the final disintegration product of the uranium-radium series.
5. Origin of a method for the calculation of the age of uranium minerals from their uranium and lead content.
6. Demonstration that actinium is in a genetic line of descent from uranium but not from radium.

Professor Boltwood possessed great personal charm and a certain courtliness of manner which compelled attention. He was quick to sense the trials of novices and was always willing to go hand in hand with them until their difficulties were solved. His intelligent sympathy and his open and gracious manner of giving sound advice will always be remembered by those who knew him. He was quite often the instigating force in the social activities of the laboratory and was a master of the art of conversation. He was modest beyond comprehension regarding his own scientific contributions. The influence of his personality cannot be evaluated by the mere account of his achievements. It had the farther reach of the man of science in the man of culture.

Chemical Instruction Plus

The process of selecting candidates to receive the fellowships offered under the plan of study recently inaugurated in connection with the Chair of Chemical Education at the Johns Hopkins University[1] has brought to light some facts and opinions which seem to merit comment and further consideration. Since a careful selection of students is one of the essential features of the projected study, instructors and other persons listed as references by the candidates were requested to fill out forms which provided ratings on the following qualities:

[1] For details see THIS JOURNAL, **6**, 319–22 (Feb., 1929).

Health	Perseverance
Character	Faculty of observation
Creative ability	Enthusiasm
Book-learning ability	Conduct
Intellectual honesty	College standing

It will be noted that an attempt was made to take cognizance of all personal factors which might contribute, however indirectly, to success in the profession of chemistry. To facilitate rating, the qualities listed were somewhat more specifically defined in the printed forms furnished. College standing included scholastic records in chemistry, physics, mathematics, and English.

The fact that not all of these qualities should be given equal consideration was recognized and an attempt to arrive at a satisfactory system of weighting was made by submitting questionnaires to a large number of chemists of acknowledged professional standing—many of them in the industrial field. The results of this inquiry showed that college standing was, on the average, esteemed worthy of fifteen points out of a total hundred, as compared with eighty-five points for the other qualities listed. In other words, it is the general opinion that what a chemist is outweighs what he knows by more than five to one.

Such an evaluation is, of course, purely subjective from one point of view; yet from another standpoint it has considerable objective significance. It remains largely a matter of opinion whether or not these factors contribute, in the degrees assigned, to the making of chemists who shall achieve something of importance in the science. It is a matter of fairly well demonstrated fact, however, that these qualities are the ones by which employers of chemists judge them. They are the qualities which secure positions and which determine advancement in those positions.

The question which now arises is one that probes at the fundamentals of our educational philosophy. Can we justifiably center all our attention upon teaching prospective chemists what they should know, without any attempt at all to help them become what they should be? Otherwise put, is it the function of chemical departments to impart chemical instruction or to train well-rounded chemists?

This problem in its generalized form has been threshed out rather thoroughly as it relates to elementary education and to the efforts of our colleges of liberal arts. Even in our technical schools it has received some consideration. We are glad to note that the modern trend of opinion leans toward the broader view of the duties of the educational institution.

If we accept that view we must ask ourselves, first, how many of the personal qualities here listed are amenable to modification at so late a stage as the high-school or college age by means of any influence that the

educational institution can bring to bear and, second, how such modification as seems desirable may best be brought about. Perhaps we had as well eliminate health and character at the outset, as matters about which little can be done. Enthusiasm is, in a general sense, probably a matter of temperament; in the specific sense of enthusiasm for chemistry, it can, no doubt, be cultivated. We have remaining qualities which may be classed either as abilities or capacities which education cannot create but which it *can* develop, or as habits predicated upon the ideals of the individual.

Creative ability and the faculty of observation may both be cultivated in the ordinary course of instruction by not only offering the student an opportunity to exercise them but by so planning his instruction that he is compelled to employ them. It is highly probable that more people lack these qualities because of atrophy or arrested development than through any innate deficiency.

Intellectual honesty and perseverance represent ideals of conduct which may well be implanted as professional ideals. Here, example is, of course, more effective than precept and suggestion than direct attack. Professional ideals are unconsciously molded by professional environment just as general social ideals take form from social environment. In either case, sermons and lectures are of little effect. The desire for the approval of one's fellows and superiors is the motivating factor in either case.

The attempt to broaden the influence of chemical instruction need not, therefore, involve any revolutionary upheaval. It requires only a closer attention to methods of instruction and to the creation of incidental impressions.

NATURE WAS NOTABLY AIDED*

A. V. H. MORY, BAKELITE CORPORATION, BLOOMFIELD, NEW JERSEY

Said the president and founder, addressing the research staff: "Nature waited many centuries for some one to provide the balance, crucible, and flask in order that she might begin to impart to us some of her wealth of creative knowledge. The potentialities thus within our grasp are attested by her wonders on every hand. Ever faithful to tradition and a stranger to caprice, her unaided working is at once an anchor of safety and a drag on present-day progress. Her own achievement of change is not for one day and generation and may not accord with our twentieth century desires, except as we learn her hidden ways of working and lend a hand by providing tools and a work shop. Thus may it be brought about that epochs become hours and new miracles stand forth. I for one would sit at Nature's feet and give her aid."

Certain it is that Nature was long ages evolving the amber-yielding conifer, and then for further long ages she left its resinous exudate to harden neglected in the earth. She was probably an equally long time developing the *Coccus Lacca* and teaching it to secrete its larva-protecting lac, which man has appropriated and modified to a form he calls shellac. In all this there is not even the suspicion that Nature gave any thought to man and his latter-day desires. If she were to undertake to make pipe bits, varnishes or electrical insulation, she probably would make them of materials better suited to the purpose than are any she has developed for other uses. But it would be a long time to wait.

Man himself has been very slow even in adapting for his own use the good things Nature has provided, while it is within only a few generations that he has begun to enjoy the use of materials created to his own specifications. This has come about through his "discovery of discovery," his substitution of revolution for evolution, in which by an arbitrary assumption of power over conditions, he has found himself able to apply Nature's laws with certainty and dispatch in the furtherance of his own creative purposes. Thus are new wonders created; thus is time annihilated.

It was by such means that phenol resinoids came into being. Nature had never been asked to produce anything just like them before, and she had no reasons of her own for doing so, but industry's demand for better plastics than had been already produced prompted more than one worker to lend a hand. In the end, as shall appear, Nature was notably aided.

The way had been prepared back in 1871, by that eminent German chemist, Adolf Baeyer, who studied the behavior of phenols and aldehydes when heated together and allowed to react. The able doctor was both interested and annoyed by the results of this reaction—interested in the

* Photos by courtesy of Bakelite Corporation.

fact that resinous products were so often obtained, and annoyed because these resinous products did not lend themselves to the usual methods of purification and identification. Such non-crystalline, amorphous masses were simply discarded—the end of an unsuccessful experiment.

During the next thirty years or more there were a number of workers who tried to give aid in the production of a resin of industrial value, but without success. Such resins as were produced were either like ordinary rosin, fusible and soluble, but not nearly as cheap, or else they swelled up under more than moderate heat to shapeless, porous, hard, infusible, insoluble masses that had no value, since they could not be re-fashioned into usable forms. The resins that remained fusible and soluble under heat, though of little or no use, found the greater favor and patents which issued covering their production were careful to specify the means by which a permanently fusible and soluble resin could consistently be obtained.

It remained for Dr. L. H. Baekeland, American chemist, fresh from marked achievement in photographic fields,[1] to render the aid that made possible the production of synthetic resins of large industrial value.[2]

In research the objective is not only uncertain of attainment but also is indeterminate in character. As Baekeland himself has said, "In research one may go hunting for rabbit and bring home a bear." At first he hoped to get merely a satisfactory substitute for shellac. Instead he obtained a new and different product, superior in its properties to any natural resinous substance. This he achieved through sheer originality. Earlier workers had followed well-beaten paths hoping to find the object of their search along the way. Baekeland chose an abandoned path that led into a thicket, and then hewed his way through into undiscovered fields.

As with the motor car, first made to look like its predecessor, the horse-drawn vehicle, so with synthetic resins, most prized were they that most resembled natural resins. It remained for Baekeland to recognize the possibilities tied up in the hard, infusible, insoluble, porous, shapeless mass that other investigators had sought to avoid. He determined not to be content with a mere substitute for shellac or any other natural gum or resin. By bringing under subjection the refractory substance with which

[1] Only a short time before he had developed and sold the process, factory, and business of "Velox" photographic paper, which employed what was then a revolutionary method of making prints, *viz.*, by artificial light. Such papers under various names have almost entirely replaced the slow and uncertain sunlight printing papers.

[2] For a detailed discussion of Baekeland's work and that of his predecessors, the reader is referred to original sources. See the following by L. H. Baekeland: "The Synthesis, Constitution, and Uses of Bakelite," *Ind. Eng. Chem.*, **1**, 149–61 (Mar., 1909); "On Soluble, Fusible, Resinous Condensation Products of Phenols and Formaldehyde, *Ibid.*, **1**, 545–9 (Aug., 1909); "The Chemical Constitution of Resinous Phenolic Condensation Products" (Willard Gibbs Medal Address), *Ibid.*, **5**, 506–11, 620 (June, 1913). In these papers reference will be found to the publications of the earlier workers.

no one had been able to do anything, he would create a new and superior product, unlike anything known in Nature.

He first endeavored to find a solvent for the shapeless hardened mass but without success or even a reasonable, stimulating hope of success. Then one day, needing a rest, he left his assistant with instructions designed to exhaust all the possibilities of dissolving the refractory material and went away for a few months. When he returned no solvent whatever had been found. Nevertheless, here was a product worth having, a problem worth solving. To the solution of the problem he brought renewed vigor and a cleared brain. If he could not control the product after it was formed, he would control it during its formation. If he could cause it to become hard, strong, and unchangeable after it had been given the final form desired, its resistance to change, heretofore a failing, would at once become a virtue.

From then on, he tells us, things came fast, and one day in February, 1909, after about three years' work in all, he announced to his fellow chemists of the New York Section of the American Chemical Society the subjugation of the unruly reaction and the creation of a new plastic substance of great industrial promise. For his new product his patent attorney coined the name, *Bakelite*, a trade-mark that has since become a synonym for something better for many different uses.

Whenever superiority presents itself, a world of more or less conscious need is waiting to put it to work. The electrical world had long been waiting for Baekeland's new product, and well knew it. Along with the new product came the automobile, which would not have attained its present trouble-free state without it. Radio found it waiting, put it to work, and burst over night upon an unsuspecting public; and now the purely structural and mechanical fields appear destined to provide even greater opportunities for usefulness.

But why such a multiplicity of applications for only one material? There are a number of reasons.

First, the new substance possessed an unprecedented combination of desirable properties. Under Baekeland's control it assumed an initial soluble, fusible state which could be made to pass quickly under suitable conditions of heating to a final, hard state in which it was insoluble, infusible, and strong, had high heat resistance, high insulating value, was impervious to water and to oils, and had high resistance to corrosive and other chemical agents.

Thus in a molten, a dissolved, or a plastic condition it could be employed with certain non-fluxible, durable materials long in need of a fluxing agent that would also serve as a binder of enduring character comparable with their own. Foremost among these is that time-honored structural material, wood, tough and non-corrodible, but possessing the weakness of non-

homogeneity and of readily absorbing moisture. It is of historic interest that Baekeland's first patent had as its objective the impregnation of woods with his super-resin, thereby providing added strength and density as well as imperviousness to water. We shall see how later he achieved much greater success by reducing the wood to a finely divided state and then reassembling it, as it were, by means of his binding agent, into any new shape desired, thereby also producing a homogeneous product of great strength and permanence. As a variation of this, he impregnated cloth or coated paper with his new binder, piled layer on layer and pressed them to enduring *board*. Later the paper product was made to bear realistic, though superficial, likeness to the grain of natural wood, but devoid of the shrinking, splitting weakness of the natural grain of all woods. With the super-resin was thus made a super-wood. That these processes and products should have proved to be industrially so successful was largely because of the extraordinary properties of his binding substance. In addition, the new binder could be brought to the hardened state at temperatures unharmful to its fibrous filler, and the time of hardening was short, giving low fabrication costs, while the dimensions, shape, and finish of the fashioned article could be controlled to a high degree of accuracy all in one operation.

But we are ahead of our story. Let us return to the porous, unruly mass studiously avoided by earlier experimenters. It was infusible, insoluble, strong, hard, and inert, but shapeless and useless because thus far uncontrollable at the time of its formation. There are few substances more resistant to change than our ceramic materials when once they have passed through the kiln, but they would be of little use were they not first plastic clay in the fashioner's hands. And so Baekeland's problem became, first, that of finding for the unworkable material a fluidic or plastic state, and second, that of finding the conditions that determined its transformation into its final, hard state and bringing about such transformation after it had been cast or molded into the exact form desired.

As a matter of fact, he did better than this. He produced not only a dense, non-porous product, but also one whose properties were superior to those of the substance he sought to duplicate and control.

Finally, after painstaking and systematic laboratory research he was able to announce the exact conditions under which the new product could be created in any one of three different states: *Bakelite A*, which is soluble in the usual solvents, capable of being melted, cast in molds, and transformed by added heat into an intermediate state, *Bakelite B*, which is insoluble, though caused to swell by solvents, infusible, but rendered plastic under heat, and is transformed by further heating into the final, hard state, *Bakelite C*.

But we were speaking of the methods by which all this was brought about. First, Baekeland found necessary the presence of a suitable cata-

lyst, one of those promoters of chemical change unknown to the ancient alchemist, but thoroughly capable of sating his appetite for the mysterious. The nature and quantity of catalyst employed and the ratio between the phenol and aldehyde, Baekeland found to be the important factors determining whether there would be formed permanently fusible, soluble resins, which he called *novolacs*, or the potentially reactive *A*, *B*, or *C* type products, which he later designated *resinoids*, the better to distinguish them from the natural resins on the one hand and from the permanently fusible, soluble synthetic resins on the other.

Baekeland found that an acid catalyst and excess of phenol favored the formation of the novolacs, while the resinoids were best produced in the presence of ammonia or of other alkaline catalysts in a certain limited proportion and with the chemical equivalent or excess of formaldehyde.

Having learned to produce his resinoid at will, he turned his attention to hardening it in a dense form, free from bubbles. This he could do by heating for days or weeks at a moderate temperature. But Baekeland chose a quicker way. As is well-known, chemical change regularly proceeds at an increasing rate with increase of temperature. The chemical change involved in this interesting transformation was a so-called condensation, in which a little water is *split off* as the molecules combine, followed by a solidification, known as polymerization, a regrouping of the substance within itself, a union of molecules to form larger molecules of more complicated structure.

Baekeland condensed and polymerized his resinoid in a few hours or even a few minutes, instead of weeks or days, by heating it well above the temperature of rapid vapor formation and at the same time applying sufficient pressure to prevent foaming. Others had carefully avoided heating except very slowly and at very low temperatures, knowing that any greater heat would spoil the whole operation and result in the formation of a porous, spongy mass. Baekeland's method was simple, but not obvious, for it had never been done before, and the inventor had no difficulty in obtaining for his invention letters patent, now long known as the *heat and pressure* patent. The process as applied to the production of his well-known amber-like product, Baekeland conducted in a pressure tank, called a *Bakelizer*. Later, we find him applying the heat and pressure principle in hardened steel molds, the resinoid product being made plastic instead of fluidic when hot, by addition of a fibrous filler. In fact, the polymerized transparent resinoid was destined to become of minor economic importance when compared with the plastic products he later developed, employing as the fluxing agent the fusible resinoid which when hardened by polymerization under heat and pressure became a superior bonding agent.

The pure, polymerized resinoid was marketed under the name *Transparent Material* and was for a time the principal product. Who is not

familiar with the pipe bits and other smokers' articles of amber hue, clear and cloudy; with the beads and other ornamental articles made of resinoid of divers hues; with the bottles, cylinders, and burets for holding and measuring that highly corrosive agent, hydrofluoric acid, which eats up all glass containers?

It is this same potentially reactive phenol resinoid which is the fluxing agent and finally the bonding agent of the various phenol-formaldehyde condensation products that have been developed in response to industrial demand for a plastic material of superior properties. The superiority of phenol resinoid products lies not only in their strength and rigidity when fabricated and their resistance to most disintegrating agents, but also in their retention of these qualities and of their initial form, luster, and electrical properties practically unimpaired for an indefinite period. They may be employed in the production of an endless variety of objects at a minimum of cost in time and labor. Thus is opened up a wide field of usefulness in the mechanical as well as the electrical arts.

INSOLUBLE, INFUSIBLE, AND UNATTACKED EVEN BY HYDROFLUORIC ACID

Protective Coatings

It was only a step to lacquers and varnishes consisting of resinoid *A* in a suitable solvent. The thin film remaining after the evaporation of the solvent, when condensed and polymerized by baking, gives a coating which has all of the desirable properties of resinoid *C*, of which in reality it consists. Metals easily tarnished or corroded are thus protected against atmospheric attack, or against acid solutions and various other corrosive agents employed in manufacture.

As a later development a coating of increased flexibility has been produced which by baking may be made to adhere securely to metals when distorted or subjected to sudden and wide changes of temperature. Thin paper coated with this flexible resinoid is unrivalled in its dielectric strength, making higher voltages safe and thus increasing the carrying capacities of wires and cables, with resultant economies in the distribution

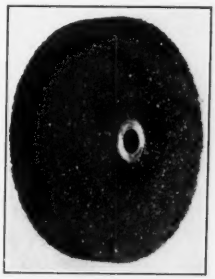
of electric current. Heavier paper thus coated, dusted with abrasive particles and baked, gives a sandpaper, flexible and waterproof, which is successfully employed in automobile finishing. In this process the metallic body surface and each coat of paint or lacquer is rubbed down in running water, a condition of use under which ordinary sandpaper employing glue as an adhesive is plainly ill-suited.

Grinding colored pigments into either the regular or the flexible lacquer or varnish gives enamels combining decorative value with durability.

Resinoid Cements

As is to be expected, a cement of exceptional strength and permanence may be prepared with resinoid *A* as a base. Such a cement is extensively employed in fastening the glass bulbs of electric lamps and radio tubes to their metallic or resinoid molded bases. Here are required both strength and heat resistance. As with the lacquers and enamels, the virtues of resinoid cement are brought out by baking. Thus has their employment been largely restricted to the more exacting uses in which other cements fail.

A related use is that of setting bristles, in brush making. In this a special liquid resinoid is employed.



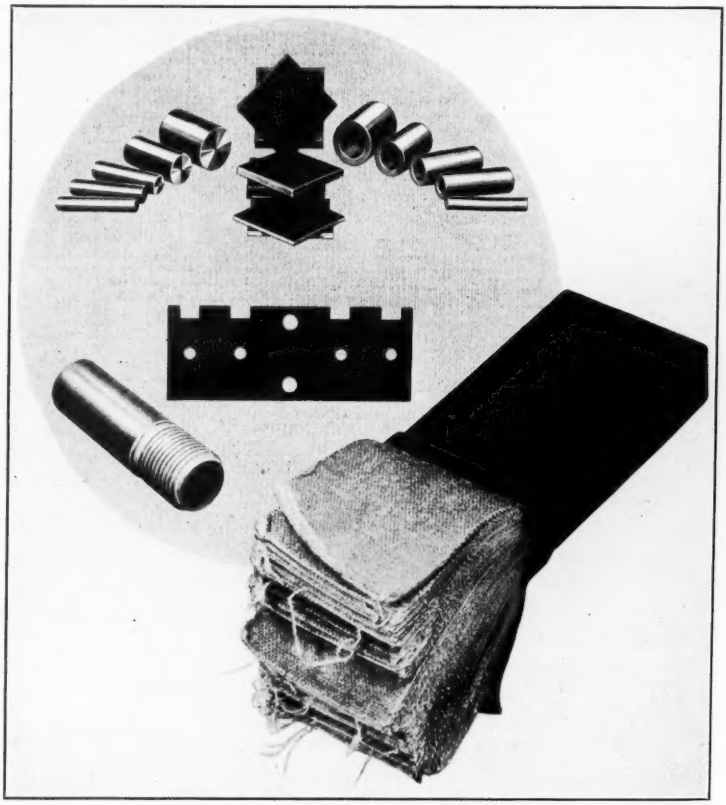
BONDED WITH PHENOL RESINOID IT CUTS MUCH FASTER AND LASTS MUCH LONGER

Interesting among the uses of phenol resinoids as binding agents is that of the manufacture of grinding wheels. Here the virtues of strength, and resistance to the softening effects of heat have been capitalized. Wheels are thus made which may safely be operated at speeds and cutting rates much greater than those possible with wheels whose abrasive particles are cemented together by vitreous binders, and, marvelous to relate, these same efficient cutting wheels working at increased speeds wear much longer than do the vitreous wheels. In interesting contrast are the self-lubricating bearings, dash pots and the like, obtained when, instead of abrasive particles, graphite is employed; also of interest are the carbon commutator brushes made with phenol resinoid binder.

Laminated Resinoid

If a solution of resinoid *A* be employed to coat paper, the solvent evaporated, and the dried paper piled sheet on sheet to the thickness desired, and if then the whole is put under a pressure of a thousand pounds to the square inch between steel platens heated by steam of about a hundred pounds pressure, there are produced strong, tough, dense plates, much used for electrical insulation and for other purposes. Well known are the radio

panels thus produced, while of growing importance is the use of this so-called *laminated* material as table and bureau tops, on which no paint nor other protective coat is required. The hard surface of resinoid *C* gives great durability, withstanding as it does the solvent effects of alcohol in any strength and the destroying effects of lighted cigars or cigarettes which

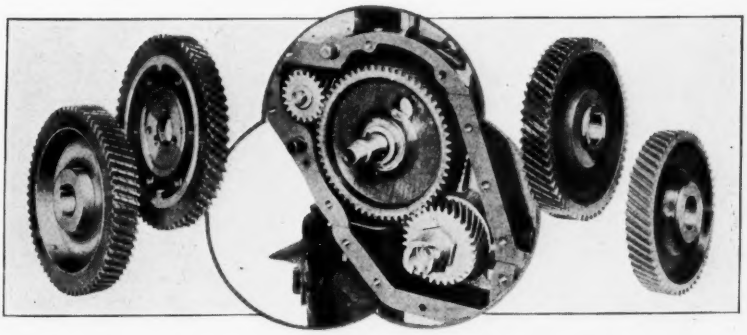


LAYER ON LAYER PRESSED TO ENDURING FORM

may have been carelessly left upon them. Nor are such furniture tops lacking in appearance, for the press plates are of polished metal giving a polished surface to the laminated resinoid, and photographic reproductions of wood graining in natural colors, or any other design or color desired, may be printed on the top layer of paper before it is coated with resinoid and pressed, thus producing surfaces of beauty and great durability.

A special *paper-laminated* known as punching stock and usually produced in somewhat thinner sheets finds extensive use in the electrical industries for small insulating parts which may best be formed by the relatively inexpensive method of punching from stock sheet material. Such punching stock, formerly made with low resinoid content to insure increased toughness is now made with high content of a flexible resinoid, thereby giving increased imperviousness to water and improved electrical properties.

If, instead of paper, cotton duck or other textile fabric is employed, gear stock may be produced, so called because from it may be cut gears to be used in place of metal gears when relative silence in operation is desired. Better gears are made by molding specially cut pieces of resinoid-impregnated fabric so laid as to give uniformity of texture to the finished gear. Molded laminated gears are employed in the timing trains of the present-



PHENOL RESINOID LAMINATED GEARS ENMESHED WITH GEARS OF STEEL RENDER DEPENDABLE SERVICE IN THE TIMING TRAIN OF THE MODERN AUTOMOBILE

day automobile. They render enduring service, and, like the steel gears with which they are enmeshed, remain unaffected by the oil necessary for their lubrication. It is in this way that airplane propellers were made and employed during the World War and are still employed where enduring service is the prime essential.

Another use for canvas-laminated is that of valve disks for heavy duty pumps, in which use their toughness and resistance to water and oils make for long life.

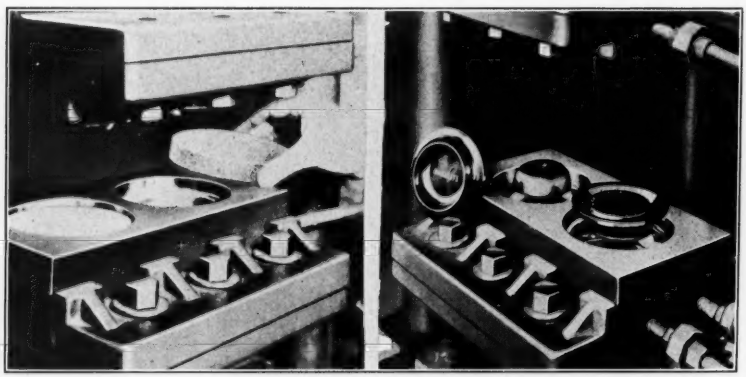
Cloth-laminated stock made of finer fabric is employed for special uses, electrical or mechanical, in which a thin, tough, flexible material is required. One such interesting application is that of the diaphragm for a loud speaker.

Both the paper- and the cloth-laminated resinoid are produced in the forms of rods and tubes of various shapes and sizes as stock material for special uses.

A more recent development is a varnish-impregnated fabric cut into small pieces, which is called *molding fabric*. Like the molding materials, which next claim our attention, it is fashioned in hardened steel molds under heat and pressure. Objects thus made from molding fabric possess the extraordinary strength and toughness of cloth-laminated stock with the advantages that are given by molding, with its rapid production of three-dimensional forms.

Molded Resinoid

It is through lending itself to the molding art that phenol resinoid takes on the greatest variety of forms and finds the greatest variety of applications. Neither resinoid *A* nor even resinoid *B* alone are adapted to fash-

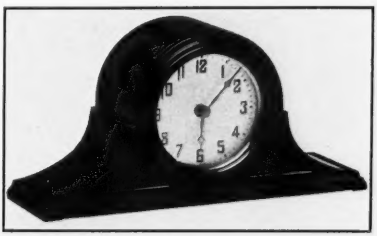


A HIGHLY POLISHED MOLD GIVES AN EQUALLY HIGHLY POLISHED MOLDED ARTICLE
Preformed cake of molding material. Finished ash-tray removed from mold.

ioning in a mold. What is needed is just the right degree of plasticity under the heat of molding so that every detail of the mold may be filled out without escape of the molding material. Such desired plasticity Baekeland provided by introducing fibrous fillers, notably finely ground wood, commonly called *wood flour*. By adding wood flour he was able to provide not only the desired plasticity but also a degree of toughness in the molded product not possessed by the polymerized resinoid alone.

As a matter of fact, halting the reaction at just the right stage in the production of a resinoid suitable for use in a molding material was found rather difficult in manufacturing practice. To avoid the necessity of this, advantage was taken of the discovery that permanently fusible, soluble phenol resin, which does not have this disadvantage, may be converted into resinoid by addition of the proper amount of formaldehyde or its equivalent in

dry form. Such dry formaldehyde-equivalent products are paraformaldehyde, a polymer of formaldehyde, or hexamethylenetetramine, which is the rather formidable term applied to the compound formed whenever formaldehyde and ammonia are put together, and which for short is usually called *hexa*.[3]



WITH THE SUPER RESIN IS MADE A SUPER-WOOD

An intimate mixture prepared from fusible resin, *hexa* (in which the ammonia present acts as the catalyst), wood flour, and the desired coloring matter, if any, all ground together in a ball mill, hot-rolled, again ground, and then screened to insure absence of any interfering foreign matter, is commonly employed as a molding material. At the temperature given by one hundred twenty-five to one hundred seventy-five pounds of steam

[3] This process, employing a resin of the novolac type with later addition of the hardening aldehyde, is known as the *two step* process as contrasted with the *one step* process in which fusible resinoid, or resinoid *A*, is employed. The following outline, showing the relation between *one step* and *two step* resins, is supplied by Dr. H. L. Bender.

Phenol Resins and Phenol Resinoids

The reaction between phenols and aldehydes will take one or the other of the following paths, according to conditions:

1 DIRECT RESINOID ROUTE

(One step)

Theoretical or excess aldehyde present; either with or without catalyst (preferably basic)

2 INDIRECT RESINOID ROUTE

(Two step)

Excess phenol present, either with or without catalyst (preferably mineral acid)

↓

Fusible phenol resins (*Novolac* or *two step* resins)

↓

Addition of aldehyde in presence of catalyst (generally basic)

↓

Resinoid, *A* Type

↓

Heated

↓

Resinoid, *B* Type (mixture of *A* and *C* types; point at which gel stage begins)

↓

Heated

↓

Resinoid, *C* Type

For detailed discussion of the subject consult "Phenol Resins and Resinoids," by L. H. Baekeland and H. L. Bender, *Ind. Eng. Chem.*, **17**, 225–37 (Mar., 1925).

THIS AND MORE IN THE HOME

GRAPHITE AND PHENOL RESINOID CONSTITUTE THIS SELF-LUBRICATING DASH POT

FURNITURE REPRESENTS POSSIBLE USE, AS WITNESS THESE DENTAL CHAIR ARMS

UNHARMED BY WETING. IT IS MADE FROM "MOLDING FABRIC"

such a molding material quickly fluxes and then as quickly solidifies in the heat that first softens it.

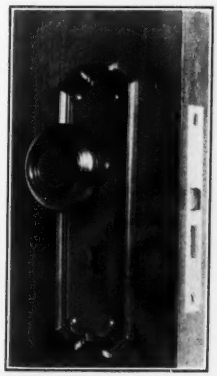
In the practice of the molding art a definite quantity of the molding material, either as powder or as a preformed cake, is introduced into a hardened steel mold, a slight excess being provided to insure complete filling of the mold, which is heated and closed as pressure is applied. The slight excess of material is squeezed out between the two parts of the mold. Removal of the *fin* thus formed is the only labor of finishing. This represents a great advantage over hard rubber. A highly polished mold gives an equally highly polished molded article, and what is of equal or even greater importance in labor saving is the fact that metal inserts, many of them threaded, so often required in electrical devices, may be positioned in the mold and embedded in the molded piece at the time of molding. Also holes and threads may be molded in the material itself, all effecting a great saving in the labor of later assembly.

Because of the low cost of fabrication that results when many objects of the same sort are required, and because of the great accuracy with which such objects can be fashioned, phenol resinoid molding materials are being used to replace not only cheaper plastic materials, but even the labor-saving die-casting alloys.

A notable trend is toward the use of phenol resinoid in the fabrication of many devices of a purely mechanical nature, thus replacing metals and even wood. The resinoid has the advantage of greater permanence of form and appearance, and often effects considerable saving in cost. Thus clock cases are molded of resinoid material, as are the vanes of a washing machine agitator. The first use of resinoid molding materials was in the production of tiny bushings, the size of mustard seeds, for the well-known Weston electrical measuring instruments; one of the latest seriously proposed uses is the head and foot pieces of a day-bed.

When greater heat resistance is required than is possible with vegetable fibrous filler, as in the case

of electric heater connecters and the like, asbestos filler is used. When special "low-loss" molded parts are required, as for radio condenser ends, the filling material may be powdered mica.

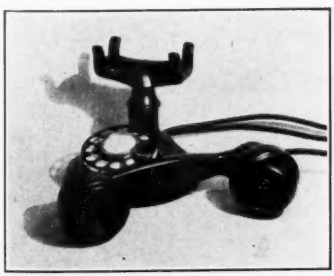


THE TREND IS TOWARD THE USE OF PHENOL RESINOID FOR DEVICES OF A PURELY MECHANICAL NATURE

Properties of Phenol Resinoid Products

The physical, electrical, and chemical properties of laminated and of molded resinoid are those of the pure resinoid modified by the materials used as fillers and reinforcing agents. Vegetable fibrous fillers give increased toughness, but are less resistant to heat, water, acids, and other deteriorating agents than is the pure resinoid itself. Certain mineral fillers give greater resistance to deteriorating agents, but generally at the expense of toughness.

Enumeration of the many uses in which phenol resinoid products are rendering efficient service would be difficult and unduly space-consuming. Suffice it to say that such a list would include many industries and would be found to touch our lives at many points and to an extent scarcely recognized. Electric plugs and wiring devices, percolator and flatiron handles, not to overlook radio with its panels, dials, tube bases—these and more in the home. For the office there are pencils, typewriter spacing bars, telephone receivers and mouthpieces, calculating machine frames and parts. In the factory with its electrical machines and devices requiring dependable insulation, and wherever resistance to corrosive fumes and liquids is required, phenol resinoid products render valuable service. Of the latter use, a good example is afforded by the rayon industry with its spinning buckets and spindles molded of resinoid and its metal spools protected by flexible resinoid varnish. The modern automobile would be far less trouble-free without the heat-, oil-, wear-resisting service of phenol resinoid in timing gear, distributor head, coil case and other parts, a score in all. As on the road, so in the air; the first plane to cross the Pacific to Hawaii employed a propeller every inch of whose nine-foot span and every pound of whose hundred weight was molded of phenol-resinoid-impregnated canvas.



THE RECEIVER-TRANSMITTER IS OF MOLDED PHENOL RESINOID

Furniture, automobile bodies, air-

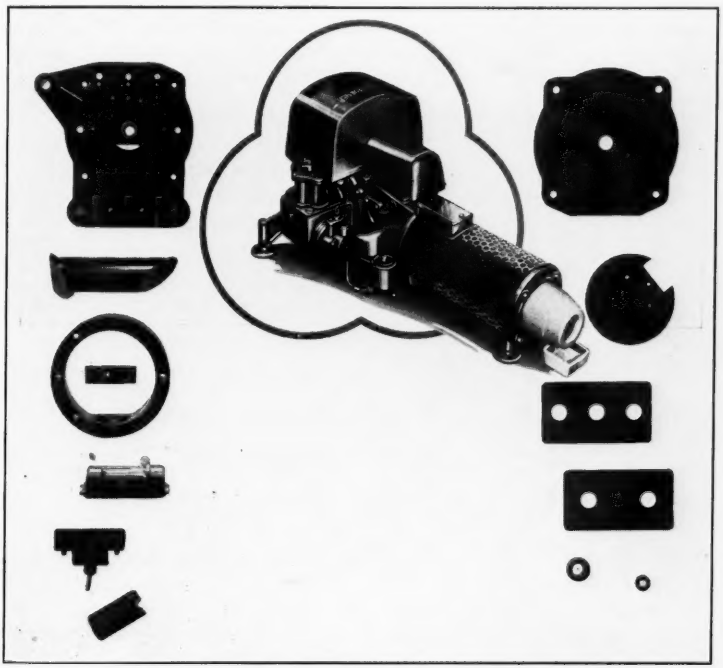
PROPERTIES OF PHENOL RESINOID PRODUCTS*

	Pure polymerized resinoid	*Laminated phenol resinoid*		*Molded phenol resinoid*	
		Paper	Fabric	Wood-flour filler	Asbestos filler
Mechanical properties:				(Old test piece)	
Tensile strength, pounds per square inch	5000–11,000	8700–22,000	8500–12,000	3500–6500	3500–5000
				(New test piece)	
				6000–12,000	5000–10,000
Impact strength, foot pounds per square inch (notched test piece)	0.5–25	5–25	10–65	1–11	1–6
Modulus of rupture, pounds per square inch	12,500–20,000	15,000–30,000	10,000–30,000	5000–12,000	5000–10,000
		(Parallel to laminations)			
Compression strength, pounds per square inch	26,000–33,000	20,000–45,000	20,000–45,000	18,000–36,000	18,000–36,000
		(Perpendicular to laminations)			
			35,000–47,000		
Hardness:					
Brinell	30–45	35–45	33–38	30–38	38–42
Sclerescope	75–110	84–94	60–67	78–92	75–95
Electrical properties:					
Dielectric strength, volts per mil	250–700	750–1300	250–500	250–700	150–500
Dielectric constant	4.5–7	4.5–6	4.5–6	4.5–7.5	4.5–7.5
Power factor, per cent (at one million cycles)	0.2–3	1.5–5	2–7	1.5–7	5–20 (mica filler 0.5–0.7)
Volume resistance, ohms per cubic centimeter	10^{10}–10^{12}	10^{10}–10^{12}	10^{10}–10^{11}	10^{10}–10^{14}	10^{8}–10^{10}
Deteriorating agencies:					
Age	Improves rather than deteriorates with age				
Heat	Infusible; withstands 500° F. (260°C.) without charring	Infusible; withstands heat up to charring of cellulose filler			Infusible; withstands 500°F. (260°C.) without charring
Sunlight	No effect other than surface reddening	No effect on electrical properties			
Mineral oils and gasoline	No effect on any phenol resinoid product				
Animal and vegetable oils	No effect on any phenol resinoid product				
Water:					
Intermittent wetting	No permanent effect; amount absorbed depends on time of immersion				
Continuous immersion for 24 hours (specimen 1 × 1 × 1/4 inch)	0.05–0.07%	0.2–1.0%	0.2–2.0%	0.05–0.2%	0.05–0.1%
Organic and dilute mineral acids	Little or no effect except from water absorbed				
Strong hydrochloric and hydrofluoric acids	Little or no effect	Deteriorate through attack on cellulose filler			Gradually deteriorates through attack on filler
Strong sulfuric and nitric acids	Disintegrate the resinoid and therefore all resinoid products				
Alkalies	Mild alkalies soften and strong alkalies rapidly disintegrate all resinoid products				

* Condensed from data given in International Critical Tables, Vol. **II**, 1927, pp. 296–303, and in "Properties of Electrical Insulating Materials of the Laminated Phenol-Methylene Type," by Dellinger and Preston, *Technologic Papers of the U. S. Bureau of Standards*, **16**, pp. 501–627.

plane fuselages represent not improbable future uses of phenol resinoid products. To offer serious competition to the time-honored but inferior structural materials they await only the production of cheap phenol and aldehyde.

The industry employing this *material of a thousand uses* is still in its in-



A FEW OF THE THOUSAND USES ARE HERE EXEMPLIFIED

Whether as insulation or as purely structural parts of this oil burner, all must withstand heat, oil, and moisture.

fancy. Twenty years ago Nature had not yet been led to produce the useful substance on which the industry was founded. We may confidently expect continued progress in this as in other industrial fields, for Nature is inexhaustibly resourceful and man increasingly diligent in providing the conditions and facilities for achievement.

Every man owes some of his time to the upbuilding of the profession to which he belongs.—THEODORE ROOSEVELT

A DEVICE FOR INTRODUCING A WEIGHED SAMPLE INTO A VACUUM

M. T. CARLISLE, COKER COLLEGE, HARTSVILLE, SOUTH CAROLINA

FIGURE 1

The following is a method of introducing a weighed sample into a vacuum or a reaction chamber where it is necessary that gas-tight conditions prevail as sample is introduced.

The sample is weighed into a slender, sealed glass tube with bulb (Figure 1). A silk thread is attached to the upper end of the tube and the sample bulb is then placed within a stopcock as shown in Figure 2 and lowered until only the tip of the sample tube shows above the stopcock. A rubber stopper is inserted, making the outfit gas tight. When ready to introduce sample, it is only necessary to turn the stopcock, breaking the neck of sample tube. This method has been successfully used in Coker College laboratory for introducing samples into Victor Meyer tubes in making vapor density determinations and for introducing samples of calcium carbonate in carbon dioxide determinations.

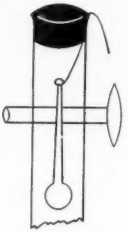


FIGURE 2

Admittance of Women to London Medical Schools. Prior to the war, all the medical schools of the University of London (with the exception of the London School of Medicine for Women) were restricted to men, but it will be remembered that during the war seven of the schools admitted women in addition. These facilities for women were withdrawn a short time ago, except in the case of University College Hospital, which still admits a limited quota. The action of the authorities of the medical schools aroused considerable discussion, and a Committee was appointed by the Senate of the University of London "to consider the question of the Limitations placed upon the Medical Education of Women Undergraduates." According to the report which has just been issued, it is considered that the facilities in London for *pre-clinical* instruction of women are ample, and it is only the withdrawal of those for *clinical* instruction which has given rise to the present inquiry. The Committee thinks that there is no valid argument against the provision of co-education, but that co-education to be successful must be voluntary. No countenance is therefore given to the suggestion which has been made that the University should enforce a policy of co-education upon the medical (and other) schools by withdrawal of recognition or other means. Such a policy, to be logical, would have to be applied all around, and this would force men upon women's colleges, and men upon the London School of Medicine for Women. Nor does it seem desirable that co-education should be universal in the medical schools of London, for such a policy might result that in some schools there would be only a very small number of women—possibly only one woman—which on various grounds is highly undesirable. The Committee recommends, therefore, and the Senate has given general approval, that its report be communicated to the schools in the Faculty of Medicine, and that the vice-chancellor be requested to invite them to consider the possibility of admitting a quota of women students in the future.— *Nature* (London), **123,** 217 (Feb. 9, 1929).

A COMPARATIVE STUDY OF CERTAIN PROPERTIES OF ELECTRONS AND THE IONS OF THE ALKALI METALS

C. H. KUNSMAN, FERTILIZER AND FIXED NITROGEN INVESTIGATIONS, BUREAU OF CHEMISTRY AND SOILS, U. S. DEPARTMENT OF AGRICULTURE, WASHINGTON, D. C.

Although during the past few years the importance of the electron in chemistry has been greatly stressed, the significance of positive ions has been largely overlooked. Let us remember that an electron is a negatively charged particle $^1/_{1800}$ of the weight of an atom of the lightest known element, hydrogen, and behaves like a negative charge of electricity with a diameter of about 10^{-13} cm. In contrast to this we have the positive ion which is about the size of the atom, that is, 10^{-8} cm. in diameter, and varying in mass from the lightest, hydrogen, about 1, to uranium, 238. Positive ions are regarded in the present day as resulting from the loss of an electron from a neutral (uncharged) atom of such elements as hydrogen, potassium, and mercury, so that the mass is practically not altered, but the electric charge now becomes one unit positive. Such ions are commonly designated by the use of a superscript plus sign as H^+, K^+, and Hg^+. Under some circumstances two or more electrons are removed from a neutral atom; in this case we have Ba^{++} or C^{+++}.

The easiest and most efficient way of producing electrons and ions is to pass a current through a rarefied atmosphere of gas at 1 to 15 mm. pressure. The difficulty with such a discharge is that we get a very complicated mixture of electrons and positive ions, in addition to positively or negatively charged molecules. The latter result from a molecule of a gas either losing an electron and thereby becoming positively charged, or from a molecule picking up an electron and thereby gaining a unit negative charge which occurs much more rarely than an electron loss.

The Electric Arc

Years ago it was noticed that accompanying the electrical or ionization properties of an arc are the chemical products of the arc. For example, some of the common products of the arc are NO, NO_2, NH_3, O_3, H_2O_2, H_2O, HCN, CCl_4, C_2H_2, C_2H_6, C_6H_6, CO_2, C_2H_4, Cl_2, etc. In the fixation of nitrogen alone, the electric arc still plays an important rôle, as about 40,000 tons of nitrogen or about 5% of the total commercial fixation is by the arc.

In general, electric arcs can be thought of as divided into *glowing arcs*, representing a high state of ionization between the electrodes of the discharge, and *corona discharges* between electrodes representing a low state of ionization. While the temperature of the arc is ordinarily given as 5000°, there are electrons within the arc with energies equivalent to 60,000°.

The phenomena in the arc are very complicated, resulting in the presence of (1) electrons; (2) positive ions; (3) gas molecules—normal and ex-

cited—and energy transfers; (4) normal atoms, excited atoms, and the phenomena of dissociation and chemical combination; (5) radiations—heat, visible, and ultra-violet.

Most of the theoretical chemistry of today settles about the relative importance of atomic and radiation phenomena, causing or accompanying chemical action. There is no doubt a very intimate connection between certain chemical reactions and the phenomena of the electric arc.

Electrons and Ions

Since the electric arc phenomena are so complicated, it is well to simplify the studies wherever possible. So much has been done on chemical reac-

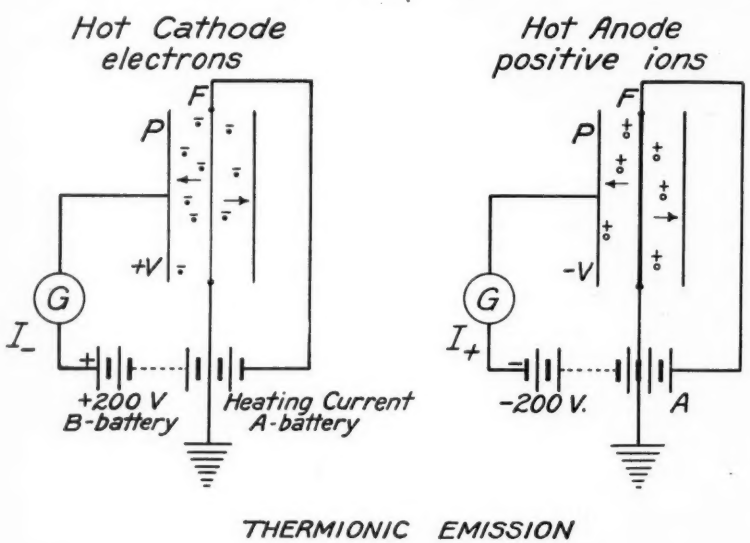


FIGURE 1

tions under electron bombardment and α-ray bombardment. In the first case, electrons from a hot tungsten filament or oxide-coated surface are caused to impinge on gas molecules at a given speed controlled by the potential of a grid or a plate in the discharge apparatus and the rate of chemical action usually measured by a change of pressure in the apparatus. In the case of α-particles[1] (which are equivalent to helium atoms stripped of two electrons) an equivalent procedure is followed. However, in this case either the radium emanation is mixed with the gas or confined in a very thin

[1] Lind and Bardwell, *J. Am. Chem. Soc.*, **48**, 2335 (1926).

glass bulb within the reaction chamber. Some time ago the writer[2] found that Fe-oxide ammonia catalysts containing an alkali or alkaline earth metal oxide gave off positively charged particles or ions when forming the hot anode of a discharge tube.

This discovery and the method of using the catalyst as a hot anode has considerably simplified experimentation with positive ions. A simple diagrammatical sketch showing the essential elements and connections for producing electrons and ions is given in Figure 1. The filaments F and collectors P are parts of a vacuum tube similar to any radio tube. The respective filaments and plate collector connections are shown for the two cases. The tungsten filament, when at a sufficiently high temperature, about 2000° in a good vacuum, and with a positive B-battery voltage to the collector, will register a negative current on a galvanometer G, or on a

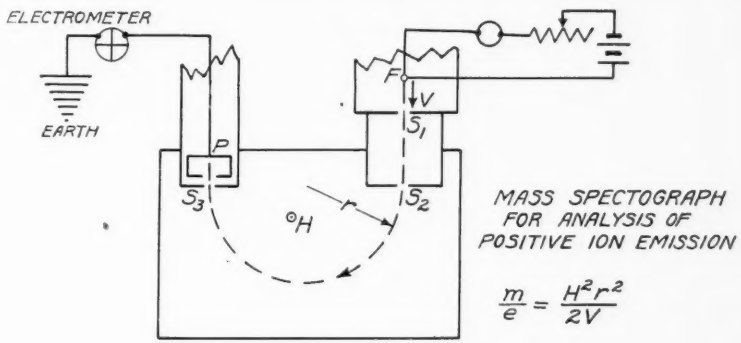


FIGURE 2

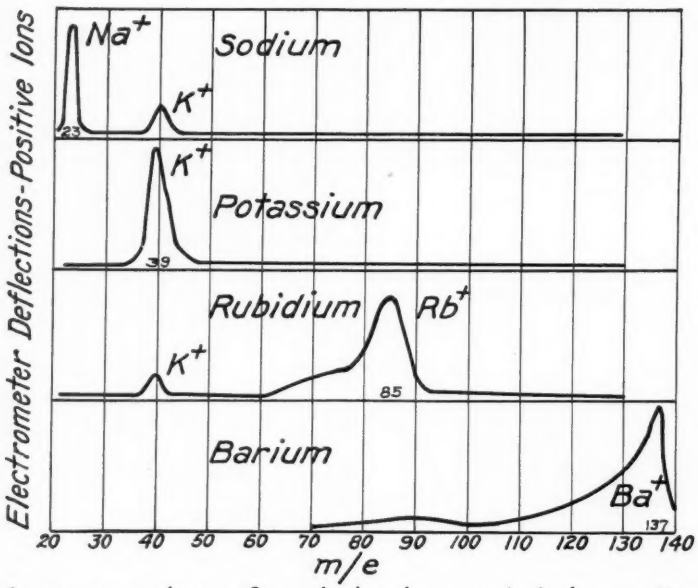
milliammeter. If a platinum strip coated with the iron-alkali catalyst is now used as a hot anode as shown on the right, and the B-battery is reversed so as to make the collector P negative to the filament F, a positive current or a deflection in the opposite direction will be observed. Positive ion currents of the order of 1×10^{-4} amperes per square centimeter of hot coated surface have been observed from these surfaces.

In order to determine just what the positive current consists of, a mass spectrograph was used as shown in Figure 2.[3] F is the catalyst-coated strip mounted in a well-evacuated chamber in front of a narrow slit S_1 and S_2, which are at a negative potential or voltage so as to pull the positive particles in the direction of S_1 and S_2. Some positive particles go through

[2] *Phys. Rev.*, **25,** 892 (1925); *Science,* **62,** 269 (1925); *J. Phys. Chem.*, **30,** 525 (1926); *J. Frank. Inst.*, **203,** 635 (1927).

[3] Barton, Harnwell, Kunsman, *Phys. Rev.*, **27,** 739 (1926).

the slits and enter the square chamber which is placed between the poles of a strong electro magnet, with a field strength H. With the magnetic field of the right strength and direction, positively charged particles with the proper mass will take the path indicated by the arrow and traveling in the arc of a circle will enter slit S_3 and strike the collector P, attached to an electrometer. The electrometer is simply a very sensitive ammeter, measuring currents of the order of 1×10^{-12} of an ampere. The relation



Mass spectra of catalysts containing alkali and alkaline earth metals.

FIGURE 3

$m/e = \frac{H^2r^2}{2V}$ is the relation which holds for the motion of the charged particles, where m is the mass of the charged carrier, e the unit electric charge, H the field strength of the magnet, V the potential to slits S_1, S_2, and S_3, and r the radius of the arc, a constant of the apparatus.

In Figure 3 we have the characteristic observations on iron catalysts containing, respectively, Na, K, Rb, and Ba. In every case the maximum deflections for the singly charged positive ions comes where it should, for the added alkali or alkaline earth metal. In most cases additional alkali

or alkaline earth metal impurities show up. These mass spectrograph results prove very conclusively that the particles are singly charged and are positive ions of the alkali and alkaline earth metals. Similar results were also obtained from Mg, Cs, Sr, and Ca. The phenomena taking place on the escape of a positive ion are roughly shown by Figure 4. The K and Ba atoms are roughly sketched at the left of the figure and the reduced catalyst mixture shown to the right, consisting largely of Fe, Al_2O_3, K_2O and K, or Fe, Al_2O_3, BaO_2, and Ba. The Al_2O_3 is not necessary for the escape of positive ions in either case. However, it has a very stabilizing in-

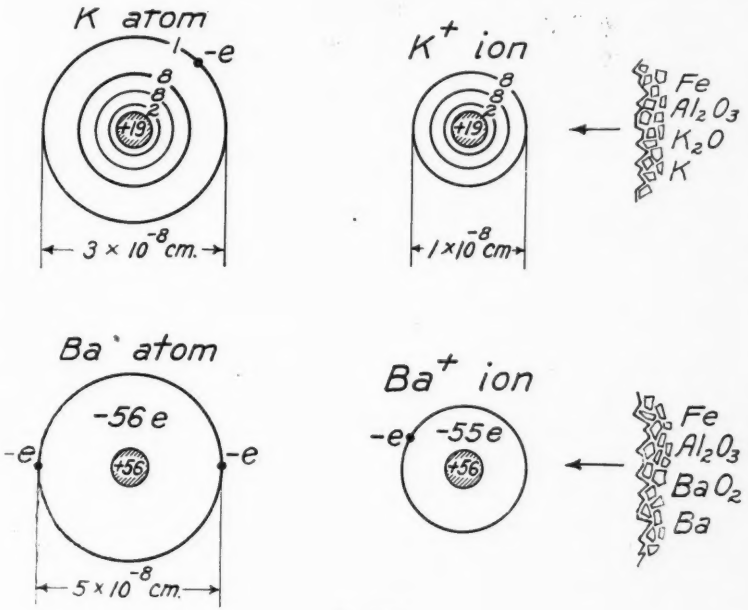


FIGURE 4

fluence in both the positive-ion emission and catalytic activity of the mixture when used in the synthesis of ammonia. We might note that although Ba has two valency or conduction electrons only one is stripped from the atom on vaporization from the hot surface.

With this source of positive ions comparable in ease of operation and constancy with the present source of electrons, many physical and chemical experiments with ions are now possible. Within the last two years considerable data have already been obtained, so that there is something definitely known about similar properties of electrons and ions.

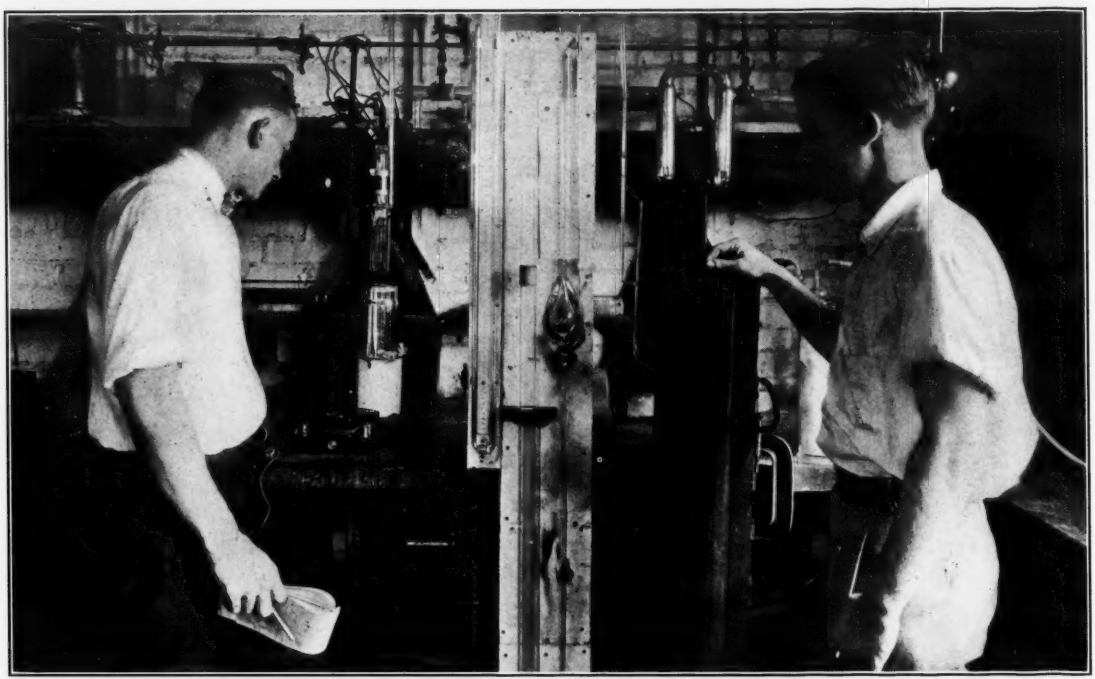


FIGURE 5.—APPARATUS FOR THE ACTIVATION OF $N_2 + 3H_2$ BY ELECTRONS AND BY K^+ IONS

Activation of $N_2 + 3H_2$ Mixture by Electrons and K^+ Ions in the Synthesis of Ammonia

A typical set-up of apparatus used by the writer at the Fixed Nitrogen Research Laboratory in an experiment to determine the relative activity of electrons and K^+ ions in the synthesis of ammonia[4] is shown in Figure 5. The set-up consists of a reaction chamber (Figure 6) in the form of a two- or three-element discharge tube attached to a pyrex glass vacuum system, to which is attached a McLeod gage. The entire glass system is thoroughly degassed to a pressure of about 10^{-6} mm. of Hg, after which a $N_2 + 3H_2$ mixture is added at a pressure of 10^{-2} cm. The reaction chamber, Figure 6, similar to the one shown in detail in Figure 7, is then immersed in liquid air, and the rate of decrease of pressure or synthesis of ammonia measured as a function of the speed of the electrons and K^+ ions, respectively.

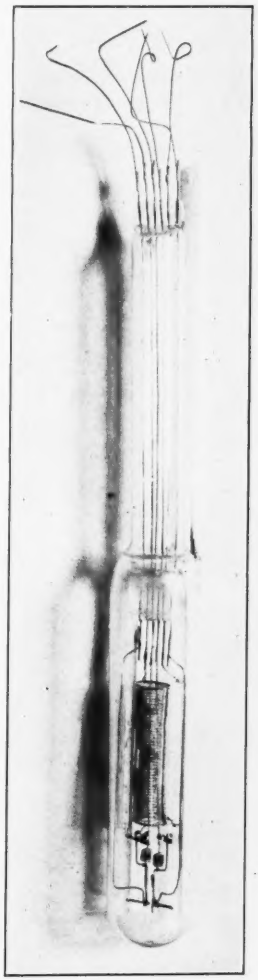


FIGURE 6.—CHAMBER OR VACUUM TUBE FOR THE ACTIVATION OF $N_2 + 3H_2$ BY ELECTRONS AND K^+ IONS

It may be well to consider the reaction chamber (Figure 7) in detail at this time. A tungsten filament and an Fe-K catalyst coated strip are surrounded by a fine platinum gauze cylinder functioning as the collector of electrons or ions, respectively. A copious source of electrons, 1×10^{-4} amperes, can be had from a convenient length, as shown, of 6 mm. commercial tungsten filament at about 2000° Kelvin. The K^+ ion source is prepared by taking a thin twisted platinum strip and coating it with a mixture of paraffin and 300 mesh Fe-K catalyst granules. With the strip heated by passing a current through it to a temperature hot enough to melt the paraffin, a uniform coating of the mixture is applied by means of a glass rod. The temperature of the strip and coating is now raised to about 1000° until the material has been securely fused to the strip. The temperature is then lowered and another coating applied at the lower temperature and then again fused at the higher tem-

[4] Kunsman, *Phys. Rev.*, **31**, 307 (1928).

perature. This process is continued until the desired thickness of coating is reached. This coated strip when reduced in an atmosphere of hydrogen at a dull red temperature gives a very satisfactory source of K^+ ions on being used as a hot anode. In case the tungsten filament is used as a hot cathode for an electron source the B-battery is reversed so that the collector is positive with respect to the tungsten filament.

The temperature of the hot surfaces can be determined by measurement with a Leeds & Northrup optical pyrometer. A calibration curve with the resistance of the filament r_3 as a function of the pyrometer readings gives a very good method of determining the temperature and keeping the hot surface at a constant temperature when the reaction chamber is surrounded by liquid air, which is the case when tests are made. The Wheatstone bridge method simply consists of making the filament one branch of the circuit as shown. The liquid air chills the wall of the reaction chamber so that the ammonia is frozen out and deposited on the walls of the vessel as the reaction progresses. The data sought was the decrease in pressure with time as measured on a McLeod gage. As most hot metal surfaces are catalysts for the ammonia reaction (that is, cause the reaction to take place at a measurable rate where at the same temperatures without the hot metal surface no observed rate of reaction would be apparent) an appreciable amount of NH_3 due to the presence of the hot surface would be expected. This effect was always determined by placing the collector at zero potential or earth. In this case neither electrons nor ions left the hot surfaces sufficient distances or at high enough speeds to cause an activation of the gases in the volume of the chamber other than on the hot surface.

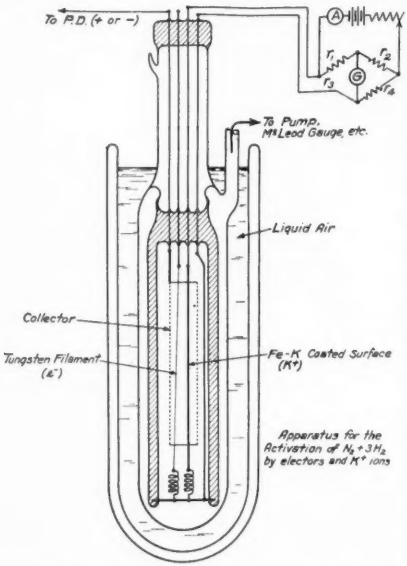


FIGURE 7.—DIAGRAM OF ACTIVATION CHAMBER AND CONNECTIONS USED IN THE STUDY OF THE SYNTHESIS OF NH_3 BY ELECTRONS AND K^+ IONS

Molybdenum springs keep the filaments taut and the long, evacuated stems enclosing the leads keep moisture and frost from condensing on the leads and injuring the electric insulation.

The results of tests with electrons from zero to increasing speeds showed

an increase in activation or synthesis of ammonia beginning at 18 volts a little above the ionization potential of hydrogen (15.9 volts) and nitrogen (16.3 volts) over that formed on the surface, and an added increase at 24 volts. However, with K^+ ions up to speeds of 330 volts no measurable increase was observed over that observed at the surface or at zero speeds. In this case the catalyst surface was very much more active than the tungsten surface, so that the experiment was proportionately more difficult.

Determination of φ or Work Functions for Positive Ions

O. W. Richardson showed that the equation $I = Ae^{-\frac{\varphi e}{kT}}$ held equally for the thermionic emission of electrons or positive ions from a hot surface. In this case I is the observed saturation current, positive or negative, A a surface constant, e base of Naperian logarithm, φ the equivalent work function in volts for the vaporization of an electron or positive ion from the surface, k the Boltzmann gas constant, and T the absolute temperature. The values of φ_+ for all ions from the catalyst mixtures was about 2 volts, actually the best value for Cs^+ being 1.95, and Ba^+ 2.12 volts, respectively.[5] Values of the work function for φ_- for the electrons gave 6.75 volts from an unreduced catalyst coated surface and 3.49 volts from a reduced surface. The reduction consists in heating the coated strip in a hydrogen atmosphere for 24 hours or longer.

Bombardment of Metal Surfaces with Electrons and Positive Ions

Interesting physical and chemical changes have been observed on bombarding metal surfaces with electrons and ions. Metal surfaces are degassed or freed from surface layers on being bombarded by electrons and ions.

When an electron strikes a cold metal surface in a vacuum, an emission of electrons takes place from the metal surface under bombardment.[6] The magnitude of this emission depends upon the metal bombarded, the extent to which the surface has been freed from gas, and the speed of bombardment. Ordinarily under 100 volts speed the secondary emission is less than the primary, but at speeds up to 500 volts 2 to 3 electrons may be emitted per primary. A secondary emission of electrons takes place for all speeds down to a few volts. On thoroughly degassing the metal surface, the secondary emission falls off from $^1/_2$ to $^1/_3$ of the value for a gas-contaminated surface.

A similar emission of electrons results when metal surfaces are bombarded by positive ions, but much less in magnitude. The most careful experiments show that there is a minimum speed of positive ions for the

[5] Kunsman, *J. Frank. Inst.*, **203,** 635 (1927).

[6] Davisson and Kunsman, *Phys. Rev.*, **19,** 253, 535 (1922); **20,** 110 (1922).

secondary emission of electrons, which varies from 100 to 200 volts. This minimum changes to about double this voltage on degassing the surface. The magnitude of the secondary electron emission under positive-ion bombardment varies from 0 to a maximum of 10% of the bombarding positive-ion current with speeds of ions up to 1000 volts. In one case Jackson[7] found the minimum potential or speed for K^+ bombarding of well degassed Al, Ni, and Mo was 200, 300, and 600 volts, respectively. In this case the maximum secondary emission at 1000 volts was about 4 % for Ni and Mo and 7 % for Al.

Very recently Gurney[8] studied the scattering of positive ions from a platinum surface similarly to the previous work on the scattering of electrons by the author with Davisson[9] and continued by Germer.[10] By scattered electrons we mean the primary electrons which strike the metal surface, have a close encounter with the atoms of the surface, and escape without loss of appreciable energy. It is these electrons which give characteristic diffraction patterns of the metal crystals as reported by Davisson and Germer. Oliphant[11] studied the secondary emission from Ni and Mo targets under bombardment of Na^+ and K^+ up to 6000 volts in a vacuum and up to 1400 volts in the presence of N_2, Ar, NO, H_2O, and CO_2.

Excitation and Ionization

By excitation we ordinarily mean a displacement of the electrons in an atom or molecule in contrast to the more drastic effect of ionization. Franck found that when Hg atoms were bombarded by electrons of 10.4 volts, an increased current was observed to the collector. This voltage was found to be the equivalent speed of an electron to ionize or remove an electron from a mercury atom, and is known as the ionization potential of mercury. At lower potential characteristic lines were photographed for the activated or excited vapor which resulted in the determination of lower energy levels for mercury. In a similar way Jones[12] found that Hg vapor could be excited by K^+ ions but in this case the speed of the ions or the potential was varied from 160 to 1200 volts and an exposure of hours was necessary in order to get measurable intensities and energy levels corresponding to exposures of a few minutes and at a few volts for bombardment of Hg by electrons.

Experiments on the motion of Na^+, K^+, and Cs^+ through gases as hydrogen, helium, argon, xenon, and nitrogen have also been carried on with the

[7] Jackson, *Phys. Rev.*, **28,** 524 (1926); **30,** 473 (1927).

[8] Gurney, *Ibid.*, **32,** 467 (1928).

[9] Davisson and Kunsman, *Ibid.*, **22,** 242 (1923). See THIS JOURNAL, **5,** 1041, 1255 (1928).

[10] Davisson and Germer, *Phys. Rev.*, **30,** 705 (1927).

[11] Oliphant, *Proc. Camb. Phil. Soc.*, **26,** 451–69 (1928).

[12] Jones, *Phys. Rev.*, **29,** 611 (1927).

view of studying the mean free path of these ions and the amount of energy lost per collision similarly as has been determined for electrons and atoms.[13] The results show a much larger, by some folds, mean free path than one would calculate.

Williams and Huxford[14] also determined the elementary charge by means of K^+ instead of on electrons and find an agreement within experimental error.

The effect of bombarding or exciting salts as lithium chloride by K^+ ions has been studied by Badareu.[15]

The foregoing discussion has clearly brought out the fact that ions such as those of the alkali metals Na, K, and Cs, are in general relatively less effective than electrons in bringing about chemical and physical changes. Further experiments should give more information on the rôle played by charged particles in excitation and chemical reaction.

Summary

1. Attention was called to the complicated electrical phenomena in the arc and the desirability of dissecting it wherever possible so as to obtain definite results from the various parts. These results can then be applied to the study of the chemical reactions taking place in the arc.

2. The description of apparatus containing a new source of positive ions was described in comparison to the equivalent electron source.

3. Physical and chemical experiments were described in which similar results were sought with electrons and with positive ions and under the same conditions as:

(*a*) The activation of $N_2 + 3H_2$ mixture in the synthesis of ammonia.

(*b*) Determination of φ the work function for charged particles from hot surfaces.

(*c*) Bombardment of metal surfaces.

(*d*) Scattering of charged particles from surfaces.

(*e*) Excitation and ionization of gases and vapors.

(*f*) Behavior of gases toward the passage of ions through them.

(*g*) Determination of the unit electric charge of a positive ion.

[13] Durbin, *Phys. Rev.*, **30,** 844 (1927); Kenard, *Ibid.*, **31,** 423 (1928); Harnwell, *Ibid.*, **31,** 634 (1928).

[14] Williams and Huxford, *Ibid.*, **31,** 1120 (1928).

[15] Badareu, *Physik. Zeit.*, **27,** 634 (1926).

Cure for Forestry Problem Is Prize Contest Subject. Prizes of $1000 and $250 have been offered by the Society of American Foresters here for the best essays describing the present forestry situation and proposing a nation-wide remedy for its solution. The contest closes in September.—*Science Service*

AN INVESTIGATION OF TYPES OF CLASSROOMS FOR CHEMISTRY AND OTHER SCIENCES IN SMALL HIGH SCHOOLS*

J. H. JENSEN, NORTHERN STATE TEACHERS' COLLEGE, ABERDEEN, SOUTH DAKOTA, AND EARL R. GLENN, NEW JERSEY STATE TEACHERS' COLLEGE, UPPER MONTCLAIR, NEW JERSEY

During the years 1924 to 1927 one of the authors of this paper conducted three science surveys by questionnaire in the state of South Dakota. During this time a large number of the small high schools in the state and in adjoining states were visited. From the results of these surveys and personal visits the greater part of the data used in this paper has been secured. On these personal visits it was found that the facilities for science teaching in small high schools over the state are very similar. It is probable that the conclusions reached for the state of South Dakota will apply also to the other states of the northwest, if not to the other states of the nation.

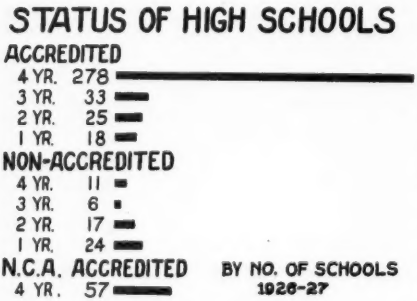


FIGURE 1.—TYPES OF HIGH SCHOOLS FOUND IN SOUTH DAKOTA

In order that the reader may fully understand the high-school science problem of South Dakota, it may be well to state that in 1926–1927 there were 469 (see Figure 1) high schools of which 278 were four-year state accredited schools.[1] Ninety-five per cent of these four-year accredited high schools were located in towns whose population was 2500 or less. Thirty-five per cent have an enrolment of less than fifty students; forty-one per cent an enrolment of fifty to 100; seventeen per cent an enrolment of 100 to 200; and

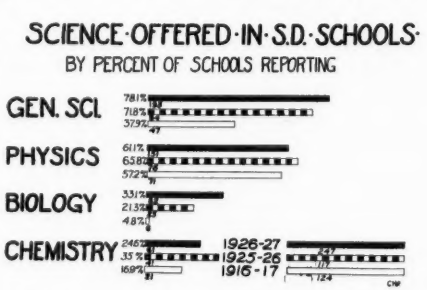


FIGURE 2.—THE PRINCIPAL SCIENCE SUBJECTS TAUGHT IN SOUTH DAKOTA HIGH SCHOOLS

* Read before the Division of Chemical Education at the 76th Meeting of the A. C. S., September 12, 1928, at Swampscott, Mass.

[1] *Directory of Secondary Schools and Educational Institutions*, **1926–1927**. Department of Public Instruction, Pierre, South Dakota.

only seven per cent an enrolment of 200 or more. In short the typical South Dakota high school is the small high school.

Some Facts Concerning Small High Schools

From a careful study of the data obtained from the science surveys of 1924, 1925, and 1926;[2,3] the *Directories of the Secondary Schools of South Dakota;*[4] and the *Biennial Report of the State Superintendent of Public Instruction,*[5] *we find that the typical four-year accredited high school of this state is situated in a town of about 500 inhabitants; has a total enrolment of sixty pupils; that the science is mainly general science or physics (see Figure 2 and Figure 3) or a combination of the two sciences with an enrolment of ten to twenty pupils; that the school offers one or two sciences; and has rather inadequate facilities for the teaching of science.*

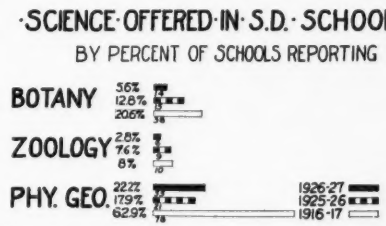


FIGURE 3.—THE MINOR SCIENCE SUBJECTS FOUND IN THE HIGH SCHOOLS OF SOUTH DAKOTA

This typical high school has three or four teachers (see Figure 4), with twenty-five per cent of all these teachers serving as principals or superintendents. *Out of a total of 530 who taught science in 1926–1927, thirty-seven per cent served also as principals or superintendents. Sixty-two per cent of these science teachers taught five or six classes per day; handled a two- or three-subject combination, usually science, mathematics, or history, and in addition supervised at least one outside activity such as football or basketball (see Figure 5).*

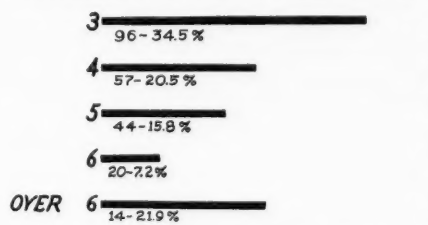


FIGURE 4.—THE NUMBER OF TEACHERS PER SCHOOL

[2] Jensen, J. H., "High-School Science Survey of South Dakota," THIS JOURNAL, **4,** 897–904 (July, 1927).

[3] Jensen, J. H., "High-School Science Survey of South Dakota," unpublished report.

[4] *Directories of Secondary Schools and Educational Institutions,* **1926–1927.** Department of Public Instruction, Pierre, South Dakota.

[5] *Seventeenth Biennial Report of the Superintendent of Public Instruction of South Dakota.*

Excluding those serving as superintendents or principals, the average salary of these science teachers was $1538.[5] *Forty-nine per cent of the teachers were graduates of denominational colleges (see Figure 6) with their science preparation largely in one science field.* On the basis of 348 different teachers reporting in 1926–1927 (see Figure 8), twenty-eight per cent have had one year of teaching experience; twenty-three per cent have had two years; and twelve per cent have had three years of experience.[3]

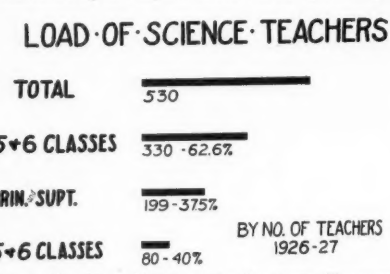


FIGURE 5.—THE NUMBER OF CLASSES TAUGHT BY SCIENCE TEACHERS IN SMALL SCHOOLS

On the basis of 348 different science teachers reporting, thirty-eight per cent are in their present position for the first year and twenty-nine per cent for the second year.[3] This means that about sixty-eight per cent of the science teachers (see Figure 7) are not thoroughly acquainted with the needs of the pupils in their respective communities. *For the most part these teachers are a constantly shifting group, seeking better salary, better facilities for work, and a lighter teaching load.*

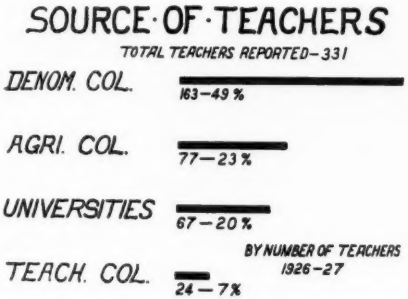


FIGURE 6.—TYPES OF INSTITUTIONS TRAINING SCIENCE TEACHERS

The average values (arithmetic mean) of the equipment available for the teaching of various subjects were: physics, $420; chemistry, $332; biology, $197; general science, $122; and physical geography, $58.[3] Other related data are shown in Table I. These figures are probably greatly in error of

TABLE I

VALUE OF SCIENCE EQUIPMENT

Subject	Av.	Med.	Q_1	Q_3	Range	No. schools
Physics	420	344	241	533	10–1850	151
Chemistry	332	250	123	482	10–1800	63
Biology	197	150	73	234	16–200	72
Gen. Sci.	122	98	56	160	10–400	110
Phys. Geog.	58	72	28	97	10–150	21

estimate in many cases and probably too low for replacement but no more accurate data are available.

Most of the schools have water and sewer connections but in the majority of cases the pipes are not connected to the improvised laboratory tables. The source of heat in the laboratory is usually the alcohol lamp.[3]

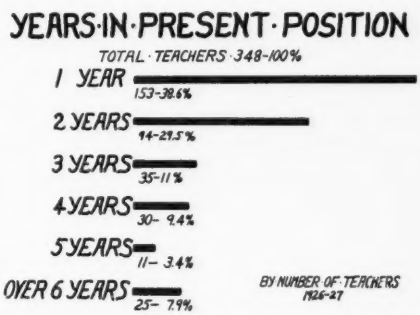


FIGURE 7.—THE NUMBER OF YEARS IN PRESENT POSITION

An analysis of the science survey data shows also that the science subjects taught in a particular year in a given school are largely determined by the science subject-matter training of the instructor employed for the year. If the teacher that is employed has had his science training in biology, this subject is taught regardless of the requirements of the pupils or the science courses taught in the school in previous years. If the instructor leaves in a year or two for another position the new teacher may be best prepared to teach physics. Then the one year of required science becomes physics. Meanwhile the equipment for biology remains unused and in most schools the apparatus is not properly stored.

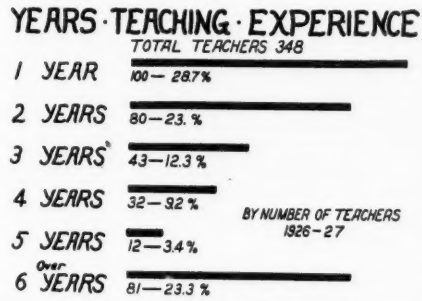


FIGURE 8.—THE NUMBER OF YEARS OF TEACHING EXPERIENCE

Needs of Science Teaching in Small High Schools

From the facts cited and other data not mentioned in this paper we conclude that some of the outstanding science needs of small high schools are:

1. A reasonable science program with a definite science sequence adapted to the needs of a given community.

2. An alternation of the science subjects offered in the first and second years of high school and those offered in the third and fourth years in order to reduce the teaching load of the instructors and thus provide more time to prepare daily lessons adequately for the subjects taught.

3. Specific and limited subject combinations for the training of those

preparing to teach science. Colleges and universities need to give most serious attention to this matter.

4. More teachers thoroughly prepared to handle subject combinations such as science and mathematics, science and history, science and agriculture. A teacher ought not to be expected to teach in more than two high-school subjects such as science and mathematics.

5. *A state law making it impossible for a Board of Education to employ a teacher to give instruction in a subject in which he is not adequately prepared.*

6. Textbooks better adapted to the needs of small high schools, because in the hands of inexperienced teachers the adopted text determines the course that is given.

7. A more comprehensive state manual adapted to the needs of inexperienced teachers, such as "The Teaching of Science" by S. M. N. Marrs and A. W. Evans, *Bulletin* **183,** September, 1924, The Department of Education, Austin, Texas.

8. A minimum list of apparatus and *a policy for the purchase of the same in order to secure the most essential pieces first for each of the sciences offered with an additional list of desirable apparatus to be added from year to year.* By this means it would be possible to build up gradually the science equipment in a school whether a particular instructor remained in the position or not.

9. A combined laboratory and classroom which will adequately provide for the sciences offered in the small school and at the same time be so arranged that it may be used for other classwork such as mathematics, history, etc. This room should also allow for the expansion of the science work to a three- or four-year sequence.

The outstanding need of these small high schools is a combination class and laboratory room. This conclusion is derived from data from the science surveys and also from that secured by numerous personal visits to quite a number of high schools. In searching for a type of installation adapted to the needs of these schools, the authors conclude, after extensive investigation, that the type of floor plan shown in Figure 9 is the most appropriate. This type of installation would reduce the floor space usually required for the teaching of science and also make it possible to secure a greater percentage of use of the room than is now the case with the laboratory and the classroom separated. Dr. Paul C. Packer in "Housing of High-School Program" shows that even in a typical large high-school building the classrooms are used only eighty-four per cent of the available time.[6] He states definitely that "in schools having less than 500 enrolment most of the specialized rooms such as laboratories must be so planned as to

[6] Packer, P. C., "Housing of High-School Program," *Contributions to Education,* No. **159,** p. 12, Teachers' College, Columbia University.

permit of interchangeability of use."[7] Schools with an enrolment of 500 or less include ninety-one per cent of the high schools of the United States.[8] "Again, specially equipped rooms which preclude other than one-purpose use result in tremendous wastes even in large schools."[9]

"In schools with a small enrolment it would be practically impossible to justify the loss due to this one factor alone. Every effort should be made to reduce this loss by planning for the maximum possible use of science rooms."[9] The room designed by the authors and shown in Figure 9 satisfies the requirements as it may be used for all of the sciences. At the same time it provides a room that may be used for any combination of subjects that the instructor may be required to teach. The laboratory and class work may be conducted in one room. The room may be used also as a classroom for such subjects as English, history, or mathematics; or as a study room; and even for such purposes as teachers' meetings.

General Specifications for a Science Room

Before we make comparisons of floor plans it may be well to state certain general specifications which this proposed room should possess to conform to standard practice as described by Strayer and Engelhardt in their "Standards for High-School Buildings."[10] According to their data the laboratory should have thirty-five to forty square feet of floor space per pupil; 200 to 250 cubic feet of air space per pupil; be rectangular in shape (in proportion of four wide to five long or two wide to three long as proposed by Butterworth); windows to the left of the pupil and on the long axis of the room; windows should be thirty-four to thirty-eight inches from the floor and grouped symmetrically.

At the front end of the window side of the room four to six feet of dead wall space should be provided. The width of the room should be governed by the height of the room. Where the room is twelve feet high and windows reach approximately to the ceiling the maximum width of the classroom should be twenty-four feet. The distance between windows should not be more than twelve inches, and the total glass area should be one-fourth to one-fifth of the floor space. Blackboards should be at the front and on the side to the right of the pupils.

Since artificial illumination and window shades will probably be the same in science rooms as in the other rooms of the building no detailed description need be given here.

[7] *Ibid.*, p. 38.

[8] Rufi, John, "The Small High School," *Contributions to Education*, No. **236,** Table I, p. 2 (91.2 per cent based on 15,139 high schools).

[9] Packer, P. C., "Housing of High-School Program," *Contributions to Education*, No. **159,** p. 40, Teachers' College, Columbia University.

[10] Strayer, G. D. and Engelhardt, N. L., "Standards for High-School Buildings," Bureau of Publications, Teachers College, New York City.

In order to provide for small science classes and at the same time for large classes in science as the school grows, the authors propose to use a T-shaped desk for pupils. In order to carry out this plan effectively, it will be necessary to have some notion of the probable increase in science enrolment and the number of sciences to be offered. A fair prediction may be made from the past enrolment in science; enrolment in the high school; and the yearly increase in enrolment in the school. In any case the room should not accommodate more than twenty pupils in a single class. Larger classes cannot be handled efficiently by the instructor. Data available from the states of Connecticut, Massachusetts, New York, and South Dakota show that eighty per cent or more of the classes in science in small schools have an enrolment of twenty or less.[5,11]

TABLE II

SIZE OF CLASSES IN RURAL AND OTHER HIGH SCHOOLS

Number of classes					Per cent of classes			
Size of classes	Mass.[11] High Schools (1–200 pupils)	Conn.[11] High Schools (1–100 pupils)	184[11] New York Small High Schools	South Dakota High Schools (1–200 pupils)	Mass.	Conn.	N. Y.	S. D.*
1–5	588	115	925	37	13.9	22.3	23.2	7.3
6–10	1019	144	1051	115	24.1	28.0	26.3	22.68
11–15	1008	109	651	141	23.9	21.2	16.3	27.8
16–20	794	71	664	118	18.8	13.8	16.6	23.3
21–25	458	28	478	75	10.9	5.4	12.0	14.8
26 and over	353	48	222	21	8.4	9.3	5.6	4.1
Totals	4220	515	3991	507	100.0	100.0	100.0	100.0

* The data for South Dakota refer to enrolments in science classes only. It will be seen from Table II that the per cent of classes in the small high schools having an enrolment of twenty pupils or less is as follows: Massachusetts 80.7; Connecticut 85.3; New York 82.4; South Dakota 81.1.

Considering a class of twenty pupils as a maximum on the basis of the data included in Table II it will be necessary to provide a room twenty-two feet wide and thirty-one feet long with a stock room ten feet wide and twenty-two feet long as shown in Figure 9. Such a floor plan would provide for eighty per cent or more of the science classes in small schools. This installation with furniture complete as shown in Figure 9 would cost approximately $2747, f. o. b., as follows:

[11] Ferriss, Emery N., "The Rural High School," Dept. of the Interior, Bureau of Education, *Bulletin* No. **10,** p. 7, 1925.

COST OF SCIENCE FURNITURE FOR A COMBINED LABORATORY AND CLASSROOM WITH APPARATUS ROOM FOR TWENTY PUPILS. (BASED ON FIGURE 9)

Quantity	Number*	Item	Cost
2	8030S	Chemistry tables *modified* for 10 pupils each	$1660.00
20	A7L	Chairs	126.00
1	913X	Wall shelf on brackets 28 feet long and 12 inches wide	79.50
4	14040	Four shelf reagent racks 24″ x 6″ x 37″ high	22.40
1	1478	Key cabinet (100 keys)	19.65
1	3062	Demonstration desk	193.00
		Physics Apparatus Room	
1	1440	Shelving with sliding doors and locks	124.60
1	1413	Preparation room bench	123.20
		Chemistry Apparatus Room	
2	1440	Shelving with sliding doors and locks	249.20
1	1423	Wall table	149.60
		Total	$2747.15

* For the sake of definiteness all items are quoted by number from furniture catalogs such as the Kewaunee Blue Book for 1927, and Supplement to Kewaunee Blue Book for the year 1927.

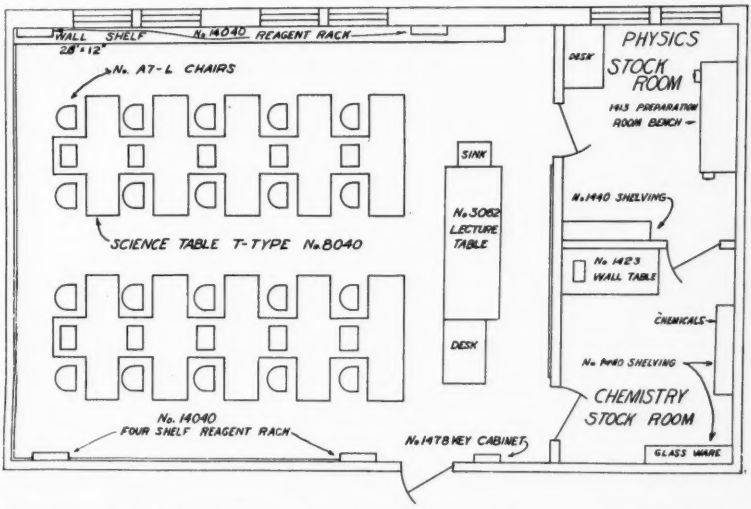


FIGURE 9.—A SUGGESTED FLOOR PLAN FOR COMBINED CLASSROOM AND LABORATORY FOR THE SMALL HIGH SCHOOL

It would be necessary also to "rough in" the plumbing to the floor line in new buildings for gas, water, and sewer. This T-type of table requires one outlet each for gas, water, and sewer for each table, and one for the demon-

stration table or a total of three outlets per room for gas, water, and sewer. It would also be necessary to specify the final arrangements of the tables in this room so that the proper slope might be given to the waste water pipe leading to the sewer. Such tables could be made in units to accommodate six, eight, ten, or twelve, etc., pupils up to the full capacity of the room. These tables are designed so that a school may install the tables necessary for six pupils with provisions made so that additional units may be added later in units for two pupils. If two rows of three units each are used to provide for twelve students in science (a unit here is considered as a T-table for two pupils), chairs could be placed in the back part of the room to accommodate larger classes in other subjects.

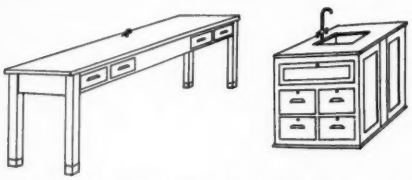


FIGURE 10.—TABLE AND SINK SECTIONS OF THE T-SHAPED TABLE

The desk illustrated in Figure 10 is designed for the school which, for the present, is without gas, sewer, or water connections. This table provides facilities for general science, biology, and physics with provisions to add gas cocks when gas is available. Two drawers are provided at each working space, one of which will take care of the more commonly used items in general science, and the other, those of biology. One of the authors has checked thirty state lists of required equipment for the teaching of science subjects and then has computed the space required to store these items.

The cost of such a unit is about $50 f. o. b. factory without gas cock and necessary plumbing. The customary practice is to allow about ten to eighteen per cent for transportation and installation of the laboratory furniture. The installation cost is such a variable factor for various types of communities that only a rough approximation can be given. The distance from the factory and the cost of labor in a given community are the determining factors in the cost of installation. For that reason, we quote prices f. o. b. at the factory on all items mentioned in this paper.

As a source of heat for schools not having gas available, we would suggest the gasoline gas machines or the large alcohol burner similar to the one manufactured by the Cambridge Botanical Supply Company as a satisfactory source of heat. The small four-ounce alcohol lamps are extremely unsatisfactory. Some instructors prefer a small gasoline torch. The noise of these outfits, however, make them objectionable. If 110-volt a. c. current is available, an electric heater similar to the Cenco cone heater can be used for most of the operations requiring heat.

Whenever gas is available the plumbing and gas cocks may be added at a cost of six dollars per desk. Whenever water and sewer connec-

tions are made available the sink unit shown in Figure 11 may be added.

With this arrangement it is possible to add to the T-type of installation as shown in Figure 11 additional sections to serve the needs of two to six

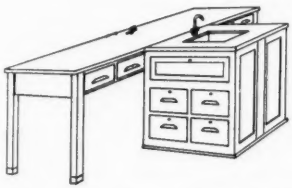


Figure 11.—The Assembly of the Unit

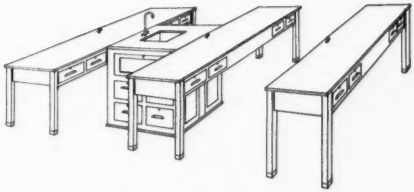


Figure 12.—Science Accommodations for Six Pupils with the Minimum Plumbing Expense

pupils in general science, biology, or physics as shown in Figure 12. The plan also makes possible the inclusion of additional sink sections as shown

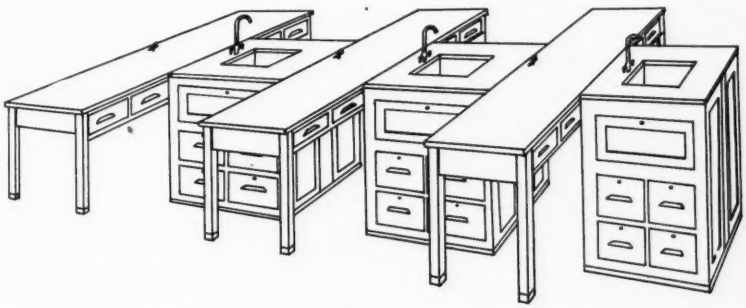


Figure 13.—The Science Desk as Recommended for Six Pupils. Gas, Water (and Electricity) at a Minimum Cost for Plumbing

in Figure 13, in order to provide water and sewer connections for each group of two pupils.

This sink section as shown in Figure 12 would cost about $110. The drawer space provided in this section is adequate to store the items commonly used by the pupils in chemistry. One of these drawers is reserved for the items used in common by the various classes in science, such as reagent bottles, mortar and pestle, wire gauze, test tube rack, etc., as shown in Figures 14, 15, and 16.

The recess under the table top in the sink section provides storage for ring stand, rings, buret clamp, Bunsen burner, sponge, etc., such equipment as is used by all science classes. This is shown in Figure 17.

The apparatus assigned to individual pupils in the chemistry course (see Figure 17) is stored in a drawer as shown in Figures 18, 19, and 20.

A teacher might infer from an examination of Figure 13 that each sink requires a separate outlet but such is not the case as only one floor connection is needed per table no matter whether two or twelve pupils are to be accommodated. Figure 21 shows how the sink sections are connected above the floor, thus avoiding expensive underfloor plumbing.

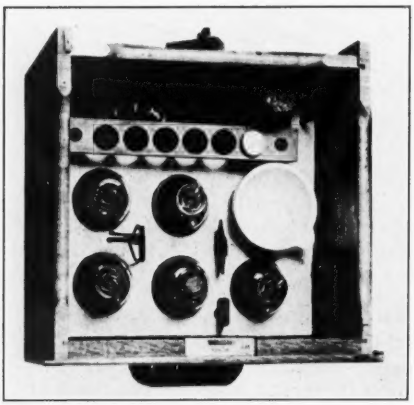


FIGURE 14.—TOP VIEW OF ONE DRAWER IN SINK SECTION OF TABLE

In order that the sink sections may be connected to the transverse member of the table quickly and easily, a special type of lead connection has been designed. As shown in Figure 22 it consists of a lead drain pipe with a flange. This is provided with a brass collar and four bolts. A connection is quickly made by drawing the two lead flanges together with the brass collars and bolts. This arrangement makes it possible to install additional sink sections conveniently at any time.

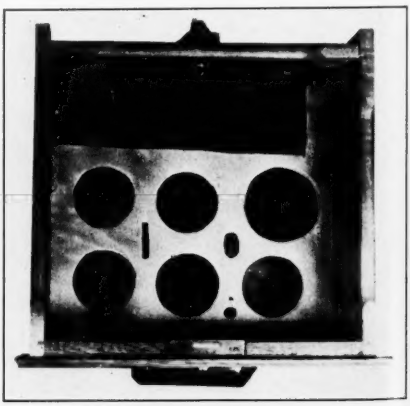


FIGURE 15.—INTERIOR ARRANGEMENT OF DRAWER

With the type of floor plan shown in Figure 24 and the desk as shown in Figure 10 it is possible to start a science laboratory with a sum as small as $150 for furniture for a class of six pupils. If each of the six pupils has facilities for experiments requiring gas and water the installation would cost $498 for desks. The complete classroom (Figure 24) with demonstration table, reagent shelves, side wall shelving, and storage cases for a class of sixteen pupils would cost about $1976. An itemized statement of cost follows:

FLOOR PLAN FOR A COMBINED LABORATORY AND CLASSROOM. FOR SIXTEEN PUPILS (WITHOUT APPARATUS ROOM)

Quantity	Number	Item	Cost
2	8030S	Chemistry tables modified for 8 pupils each	$1328.00
16	A7L	Chairs	100.80
4	14040	Four shelf reagent racks 24″ × 6″ × 37″ high	22.40
1	913X	Wall shelf on brackets 22′ long by 12″ wide	63.00
1	3062	Demonstration desk	193.00
1	1478	Key cabinet (100 keys)	19.65
2	1440	Shelving with sliding doors and locks	249.20
		Total	$1976.05

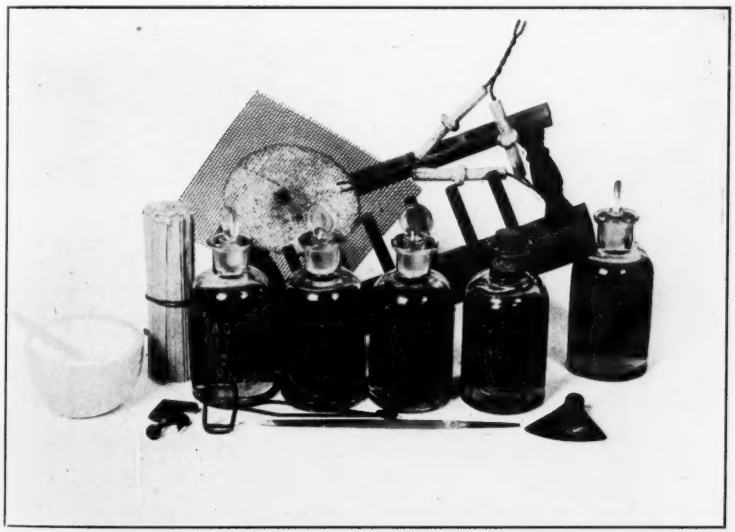


FIGURE 16.—THE APPARATUS STORED IN THE DRAWER SHOWN IN FIGURE 14

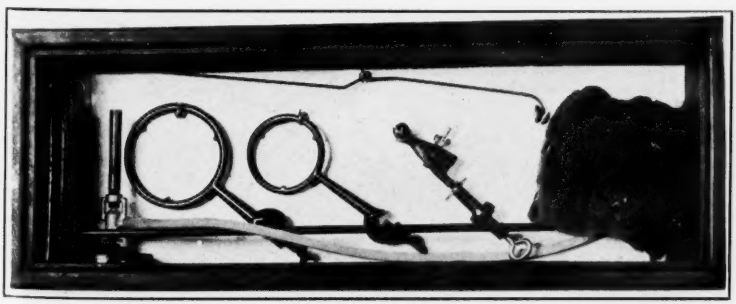


FIGURE 17.—HARDWARE AND OTHER APPARATUS USED BY ALL SCIENCE CLASSES

FIGURE 18.—CHEMISTRY APPARATUS FOR ONE PUPIL

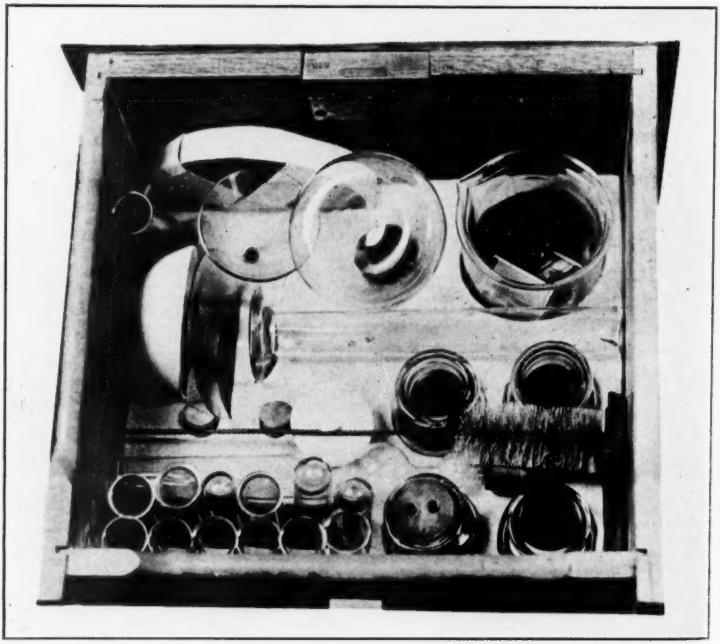


FIGURE 19.—A CONVENIENT ARRANGEMENT FOR CHEMISTRY EQUIPMENT

Note that this installation can be adequately accommodated in a room twenty-two feet wide and twenty-seven feet long. *This is the size of an ordinary classroom and it will provide for at least sixty per cent of the science classes in small schools.* The plan provides for the installation of suitable storage cases and for the addition of the T-type tables to the full capacity of the room. Any small high school may now have modern science furniture adapted to its requirements. *By following a purchasing program a school may spread the cost of the installation over a period of six to ten years if necessary at an annual outlay of about $330 to $200.*

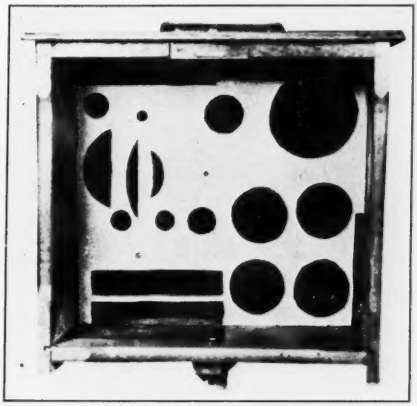


FIGURE 20.—INTERIOR CONSTRUCTION OF DRAWER FOR STORAGE OF CHEMICAL GLASSWARE

This room would take care of four or five classes in science if necessary. In brief, the proposed plan provides an extremely flexible arrangement that will function in any situation found in the smaller high schools and it also provides for the expansion of the science work without additional floor space and without a complete reconstruction of the

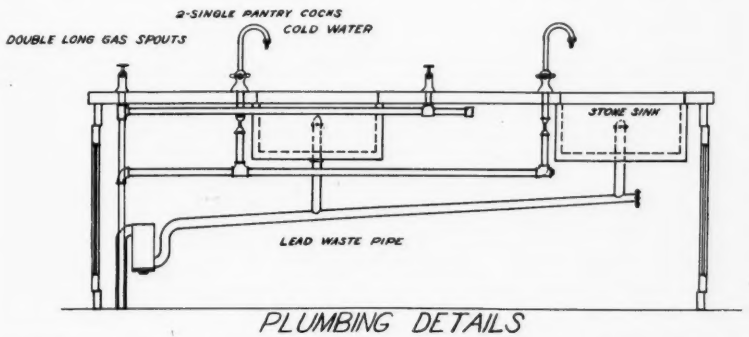


FIGURE 21.—A CROSS-SECTION VIEW SHOWING HOW PLUMBING IS ARRANGED IN COMPLETED TABLE

science room as is now almost always the case. The reader should keep in mind that the plan under discussion is designed for high schools with

an enrolment of 200 or less. This group of high schools includes nearly eighty per cent of the high schools of the United States.[8]

For schools with larger enrolment the arrangement shown in Figure 9 may be used. This floor plan provides for a maximum of twenty pupils and the cost of the installation complete as shown above is about $2747. On this basis the cost per pupil for four classes of twenty pupils each in science is about $34.

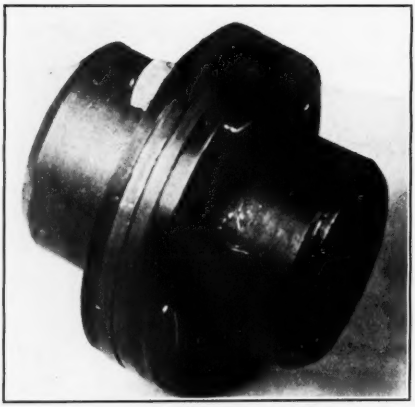


FIGURE 22.—SPECIAL CONNECTION FOR LEAD DRAIN PIPE. USED WHEN SINK SECTIONS ARE TO BE ADDED LATER. ASSEMBLED

Summary of the Advantages of the Proposed Science Room

1. All science work can be done in one room.

2. All pupils face in one direction while doing laboratory work.

3. The proposed desk provides adequately for comfortable work in either a standing or a sitting position, thus making it possible for the pupil to write notes, make drawings, do reference work, perform laboratory experiments, or observe demonstrations by the instructor.

4. This type of floor plan further permits the instructor to give demonstrations, conduct recitations, direct reference work, or to hold class discussions at any time during the period, thus eliminating fixed laboratory and demonstration schedules.

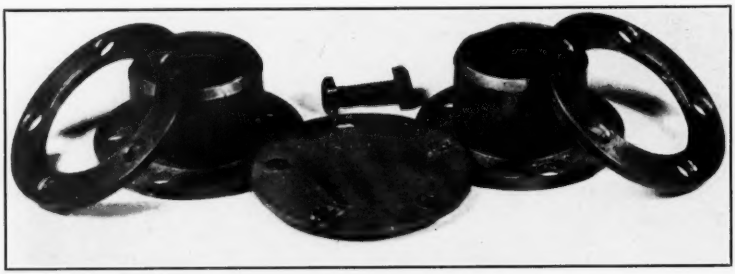


FIGURE 23.—PARTS OF LEAD DRAIN PIPE CONNECTION

5. The apparatus is stored where it is used. This results in a great

saving of time for the overworked science teacher and reduces the wear and breakage of equipment.

6. The instructor can see the entire class from any position in the room.

7. The labor involved in teaching science is reduced by concentrating all apparatus, materials, and equipment in one room as illustrated in Figure 9.

No gas hoods are provided as a study of nine commonly used chemistry manuals shows that the hoods are not used very often.[12] For small high schools a window hood such as described by Professor Lisk[13] will serve the purpose, or certain experiments, such as chlorine and hydrogen sulfide, may well be performed as demonstration experiments by the instructor with suitable absorption liquids used so that very little gas may escape into the room. It is important to keep in mind the fact that we are dealing with small classes in chemistry in these schools and usually not more than one class in a school. We are hardly justified in installing an expensive hood system when such experiments as the preparation of chlorine, hydrogen sulfide, nitric acid, sulfur dioxide, bromine, carbon monoxide, and hydrogen fluoride can well be performed as demonstration experiments. These experiments are then under the control of an experienced person and the course in chemistry will not be a nuisance to the rest of the school. It is important to note that only seven experiments out of a possible forty or fifty (fifteen to seventeen per cent of the total number of experiments) require the use of a hood.

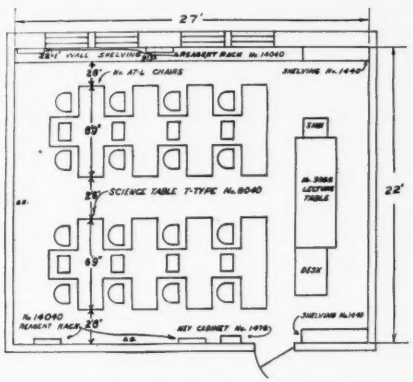


FIGURE 24.—COMBINED LABORATORY AND CLASSROOM FOR SIXTEEN PUPILS. FOR USE IN SCHOOLS THAT CANNOT PROVIDE AN APPARATUS ROOM

This proposed room as shown in Figure 9 then would provide for the minimum of one year of science for a class of six to a maximum of twenty-four pupils and for a science sequence of general science, biology, physics, and chemistry.[14] Such a room would also provide adequate facilities for

[12] Glenn, Earl R., "Requirements for Hoods in High-School Chemistry Laboratory Manuals," unpublished manuscript.

[13] Lisk, G. M., "Cheap and Serviceable Ventilating Hood," *Sch., Sci. & Math.*, 19, 721–2 (1919).

[14] "Reorganization of Science in Secondary Schools," U. S. Bureau of Education, *Bulletin* No. **26**, 1920.

the teaching of nature study, agriculture, physiography, physiology, or geography, and at the same time be suitable for use as a classroom for any other high-school subject such as mathematics, etc. Therefore it is adapted to any combination of subjects a particular science instructor might have to teach.

In order to make this plan for the progressive upbuilding of the science room effective it may be advisable to have some competent outside authority check the building plans, as is now the case in Minnesota. Here all plans for new buildings and for the remodeling of old buildings must be approved by the Inspector of Buildings of the State Department of Education. A similar plan is in operation in New York and Indiana. *A Committee on School House Planning of the National Education Association* might give some valuable assistance on this problem. Until some state action is taken the state high-school inspector or the university inspector might be responsible for checking the proposed plans.

In the following discussion chemistry is alternated with physics as this is the common practice in small high schools. With a class schedule as follows:

Period	Monday	Tuesday	Wednesday	Thursday	Friday
1	Chemistry	Chemistry	Chemistry	Chemistry	Chemistry
2		Lab.		Lab.	
3	Biology	Biology	Biology	Biology	Biology
4	Lab.	Gen. Sci. Lab.		Lab.	Gen. Sci. Lab.
5	Gen. Sci.	Gen. Sci.	Gen. Sci.	Gen. Sci.	Gen. Sci.
6	Free	Free	Free	Free	Free
7	Algebra	Algebra	Algebra	Algebra	Algebra
8	Geometry	Geometry	Geometry	Geometry	Geometry

the classroom would be in use thirty-one periods out of a possible forty or seventy-seven per cent of the total available class time per week. If only one science requiring seven periods is taught, then with five other classes meeting five periods per week, the room would be in use thirty-two periods out of a possible forty or eighty per cent of the total available class time per week. *These two programs which represent the two possible extremes of science subject combinations to be taught compare very favorably with occupancy of classrooms* as found by Packer[6] (eighty-four per cent for classroom use as compared with seventy-seven per cent in three-science programs and eighty per cent in the one-science program) and definitely meets his suggestion to so design the specialized rooms that other than laboratory subjects may use these rooms when not in use for the laboratory subjects. *The percent-*

age of weekly use of this room is over double that of the present conventional type of separate laboratory and classroom. Thus one of the greatest handicaps to the introduction of science in the small high school is overcome. If we can demonstrate the possibility of teaching a three-year science sequence in one room and have that room in use seventy-seven per cent of the total available school day, the prospect of introducing more science in the small high school is very promising indeed.

A Comparison of Two Types of Science Floor Plans

The possibilities of this proposed type of room are clearly shown in the case of an installation in a high school in a small town in Pennsylvania.

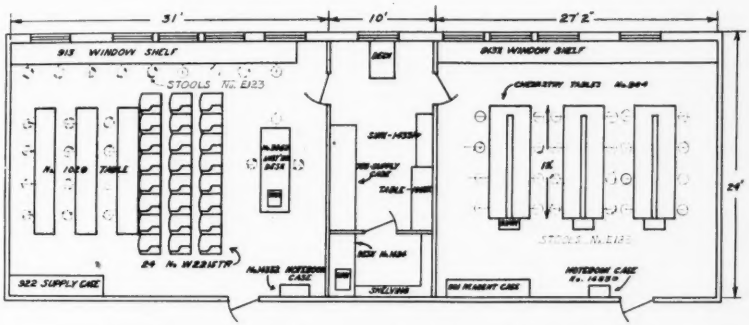


FIGURE 25.—A TWO-ROOM TYPE OF SCIENCE INSTALLATION

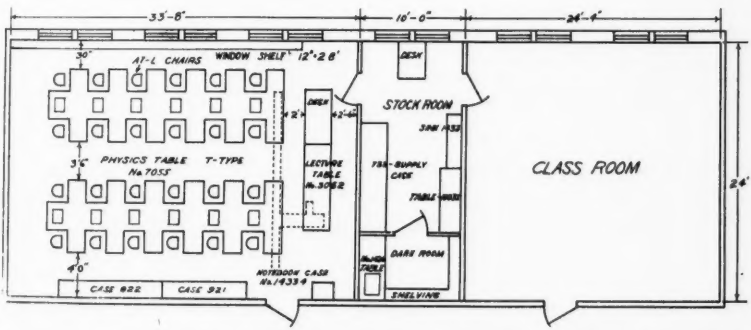


FIGURE 26.—A FLOOR PLAN FOR THE DEPARTMENT SHOWN IN FIGURE 25, WHICH IS MORE CONVENIENT AND MORE ECONOMICAL

The authors have been very much interested in this new building because it involves issues similar to those found in the northwestern schools.

This Pennsylvania town was making plans for a new building and the problem was that of planning a room arrangement that would take care of the present science classes and also provide for future growth of the science department. The town had a population of only 500 and was not able to construct a very elaborate building. The plan as proposed provided for a chemistry laboratory, a stock room, a dark room, and a combined laboratory and classroom for general science and biology, with armchairs in the front of the room and laboratory tables in the rear of the room at a total cost of $3397 f. o. b. factory for the furniture for all rooms as shown in Figure 25. This furniture would cost about $4000 when installed in the school building.

COST OF A TWO-ROOM SCIENCE INSTALLATION

Biology and General Science Room

Quantity	Number	Item	Cost
1	3062	Instructor's table	$ 193.00
1	922	Supply case	254.00
1	14332	Notebook case (75 compartments)	117.60
1	913X	Wall shelf on brackets 28′ long and 24″ wide	135.80
3	1029	Student's tables	279.75
24	W2215TR	Tablet armchairs	172.80
24	E123	Stools	48.00
		Total	$1200.95

Chemistry Laboratory

Quantity	Number	Item	Cost
3	864	Student's tables	$1205.55
1	913X	Wall shelf on brackets 26′ long and 24″ wide	126.10
1	921	Reagent case	226.00
1	14330	Notebook case (50 compartments)	99.50
24	E123	Stools	48.00
		Total	$1705.15

Store Room and Dark Room

1	1433A	Wall sink	$ 82.00
1	1003X	Table	40.20
1	733	Supply case	213.40
1	1424	Desk	155.60
		Total	$ 491.20

Grand Total for Two-Room Installation

General science room	$1200.95
Chemistry laboratory	1705.15
Store room and dark room	491.20
Total	$3397.30

Instead of the floor plan as shown in Figure 25 we suggest for comparison the plan shown in Figure 26. It will be shown that the plan in Figure 26 is a better and more economical installation for the Pennsylvania school because it conserves the available floor space; does not require an unusual expense to take care of the expansion of the science program; and it meets the needs of this community much better than the floor plan shown in Figure 25. Note that the stockroom and the dark room in the two plans (Figures 25 and 26) are exactly the same so that the comparison is based on the two-room installation as compared with the one-room installation as stated below.

COST OF A ONE-ROOM SCIENCE INSTALLATION

Combined Laboratory and Classroom

Quantity	Number	Item	Cost
2	7055	Tables 24 feet long	$2383.30
1	3062	Instructor's table	193.00
1	921	Reagent case	226.00
1	922	Supply case	254.00
1	14334	Notebook case (100 compartments)	156.85
24	A7L	Chairs	151.20
1	913X	Wall shelf on brackets 28′ long and 12″ inch wide	79.50
		Total	$3443.85
		Equipment for stockroom and dark room, as above	491.20
		Total	$3935.05

COMPARISON OF COST OF TWO-ROOM AND ONE-ROOM SCIENCE INSTALLATIONS

Total cost of all furniture for stockroom, dark room, combined laboratory, and classroom as in Figure 26	
One-room installation	$3935.05
Total cost of all furniture for classroom, laboratory, and stockroom as in Figure 25	
Two-room installation	$3397.30
Additional cost of one-room installation	$ 537.75

Note that the items are the same in the two floor plans except that one window shelf and one notebook case are substituted for the two used in Figure 25.

In order to understand the problem it may be well to add that this particular school offers general science, biology, chemistry, and physics, with chemistry and physics offered in alternate years. The enrolment was fifty in general science, thirty-five in biology, and twenty in chemistry for the year 1925. The general science and biology classes were taught in two groups each. The science program for the year was as follows:

Period	Monday	Tuesday	Wednesday	Thursday	Friday
1	Chem. Lab.	Chem. Lab.	Chem. Lab.	Chem. Lab.	Chem. Lab.
2	Chem. Lab.		Chem. Lab.		
3	Gen. Sci.	Gen. Sci.	Gen. Sci.	Gen. Sci.	Gen. Sci.
4	Gen. Sci.	Gen. Sci.	Gen. Sci.	Gen. Sci.	Gen. Sci.
5	Biology	Biol. Lab.	Biology	Biol. Lab.	Biology
6		Biol. Lab.		Biol. Lab.	
7	Biol. Lab.	Biology	Biol. Lab.	Biology	Biology
8	Biol. Lab.		Biol. Lab.		

The plan shown in Figure 26 involves an additional expenditure of $538 but the advantages gained by the one-room installation more than offset this additional cost and may be listed as follows:

1. The one-room installation (Figure 26) releases a room twenty feet by twenty-four feet for forty periods per week for other class purposes, an estimated saving of $1440 on the cost of the building, since the room is twelve feet high and the cost is estimated at twenty-five cents per cubic foot.

2. This one-room arrangement makes it possible to use the science room seventy-seven and one-half per cent of the available class time, as compared with ten per cent for the chemistry laboratory in Figure 25 or, at the most, forty per cent of the total available class time based on four classes in chemistry. *With physics alternated with chemistry as originally planned for this school, the chemistry laboratory would be used only five per cent of the total available class time over a two-year period.* The room would not be in use every other year. *One of the chief objections to the introduction of chemistry in the small high school is the small percentage of service secured from the chemistry laboratory room. The notion still prevails that in order to teach chemistry at all, a separate laboratory room must be provided with a rather expensive ventilating system for that room.*

3. If the size of the classroom (Figure 26) can be increased from twenty by twenty-four to thirty-two by twenty-four feet and the necessary plumbing connections put in at the time the building is constructed, then this room can be used as a second combined laboratory and classroom, thus providing for eight sections in science with a total capacity of 192 pupils in the two rooms. This is on the basis of seven periods per week for each science taught.

4. The arrangement of the rooms is such that both rooms can be used for other class purposes to the maximum capacity until the enrolment in science demands the full use of the two rooms.

A Further Comparison of Floor Plans

Another type of installation that is very often used for the combination laboratory and classroom for the teaching of science is illustrated in Figure

27. In this plan the combination physics and chemistry tables are placed in the back of the room and armchairs are used for the pupils in the front part of the room. The cost of such an installation is as follows:

Quantity	Number	Item	Cost
4	14224	Combination physics and chemistry desks	$1059.40
16	E123	Stools	32.00
16	W2215TR	Tablet armchairs at $7.20	115.20
1	3062	Demonstration desk	193.00
1	1478	Key cabinet (100 keys)	19.65
4	14040	Reagent racks	22.40
2	1440	Shelving with sliding doors and locks	249.20
1	913X	Side wall shelf on brackets 22 feet by 12 inches	63.00
		Total	$1753.85
The cost of the T-type installation per Figure 24			1976.05
Cost of plan per Figure 27			1753.85
Difference in cost			$ 222.20

In the T-type floor plan in Figure 24 for sixteen pupils there are ninety-six drawers and sixteen cabinets available for the storage of apparatus commonly used by the pupils in the various sciences as compared with forty drawers and thirty-two cupboards in the combination physics and chemistry desk in Figure 27.

The additional cost of about $200 is justified for the following reasons:

1. The T-type table serves as an apparatus case and provides more space for the storage of equipment than the combination physics and chemistry desks.

2. In shifting from class to laboratory work the pupils must move from the front to the back of the room with consequent loss of time and with more or less disturbance. With the T-type of installation the instructor may change from class to laboratory work with the least possible loss of time and confusion.

3. The plan using armchairs would require a room thirty-two feet long; that for the T-type installation requires only twenty-seven feet. This would require a room five feet longer than that for the T-type floor plan. If this additional length is regarded as a room five feet long, twenty-two feet wide, and twelve feet high, this space would be equivalent to 1320 additional cubic feet. At twenty-five cents per cubic foot this would amount to $330 or $108 more than the cost of the T-type installation as shown in Figure 24.

4. In the T-type room all pupils face the instructor. In the other plan, half of the pupils do not face the instructor during experimental work.

5. The T-type plan requires only three outlets each for water, gas, and sewer connections as compared with five outlets each for gas, water, and sewer connections in the armchair type of installation. In other words the expense is about twice as much for the "roughing in" of the plumbing in the armchair floor plan.

6. Each pupil has a definite place to work in the T-type of installation. All the essential materials are stored at the place where the pupil works. The necessity of moving about in the room is reduced to a minimum.

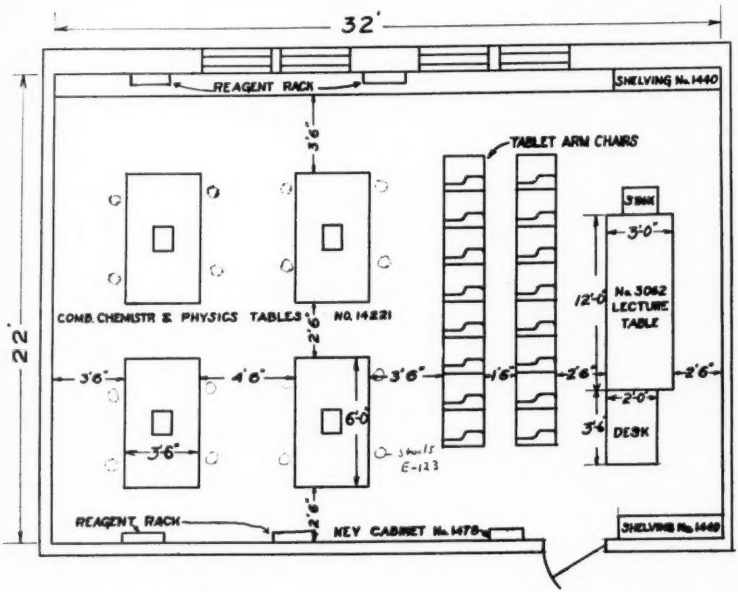


FIGURE 27.—A FLOOR PLAN WITH CHAIRS IN FRONT AND TABLES IN THE REAR

7. Tablet armchairs are not satisfactory for reading, writing, or drawing.

8. The T-type plan with the same size room will accommodate twenty pupils as against sixteen pupils in the armchair installation.

A Discussion of Certain Objections to the Combined Laboratory and Classroom

In order to secure the opinions of science teachers in seventy-six schools, Mr. J. H. Jensen conducted an independent survey of the experience of these teachers with the one-room science floor plan, here proposed, by ask-

ing each teacher to reply to twenty-five questions covering all important issues involved in the use of such an installation. A brief summary follows in which the seasoned experience of seventy-six teachers is summarized.

Question 1. *Are the pupils in the rear of the room too far away from the instructor's table to see the demonstration?*

In the type of classroom as shown in Figure 9 twenty-two by thirty-eight feet and equipped for twenty-four pupils with a demonstration desk twelve feet long, with students in regular positions, and with demonstration apparatus at one end of the instructor's table the facts by actual measurement are:

1. Two-thirds of the students are less than eighteen feet from the demonstration apparatus.
2. Five-sixths of the students are less than twenty-two feet from the apparatus.
3. All the students are less than twenty-six feet from the apparatus.

In the case of the floor plan shown in Figure 27 in which the laboratory tables are in the rear of the room and armchairs are provided to accommodate twenty-four pupils, with a demonstration desk twelve feet long, and with the students seated in the chairs, the facts are:

1. One-third of the students are seven to twelve feet from the demonstration equipment.
2. One-third of the students are ten to fifteen feet from the apparatus.
3. One-third of the students are fourteen to eighteen feet from the demonstration experiment.

These figures show that there is less difference in the distribution of the pupils from the demonstration table in the two types of floor plans than is frequently assumed. In any event this objection is not valid for small classes of six to twenty pupils.

The whole question of the visibility of demonstration apparatus depends as much on the size of the equipment and the background against which it is observed as upon the distance of the observer. *Much of the apparatus used for demonstrations today is too small for satisfactory visibility for any type of seating now in common use.*

Where rooms are equipped for twenty-four pupils seventy per cent of the teachers have found that the four pupils in the rear need to move forward for some demonstrations.

Question 2. *How do you arrange the class so that all pupils may see the demonstration?*

For the larger proportion of demonstrations there is no necessity for changing the seating of the class if the room is not equipped for more than twenty-four pupils. From time to time the pupils in the last two rows across the room are asked to slide their chairs forward in the aisles. This

arrangement gives practically the same seating arrangement as an ordinary armchair system will give. For very special demonstrations requiring vision at a close range, half of the class is asked to come to the demonstration table at one time (especially if it happens to be a noisy or boisterous class); for ordinary classes the entire class can be grouped around the demonstration table at one time, when very small things are to be observed or where very delicate color changes are to be noted as in certain chemical reactions.

Fifty per cent of the teachers state that the students are requested to move nearer the demonstration desk or come forward to the desk for certain special demonstrations that require close observation.

One instructor states that he sets up the experiment in the center of the room when minute observations are to be made.

Another states that the recitation is conducted from the side of the room in which case pupils are near the teacher and blackboard.

Question 3. *Are the table tops too high for the students when seated?*

The answer to this is "No," chiefly because pupils, as a rule, do not write an entire period at any one time. The armchair as a writing desk, on the other hand, is a total failure as every experienced high-school teacher knows.

Ninety-two per cent (69 schools) state *no* and seven per cent (5 schools) *yes*. (Not all teachers replied to every question. In every case we have used the entire number of teachers in computing percentages and have paid no attention to the percentage of teachers not answering the question.)

One states a little high for writing. Another states that a piece of wall board is provided to fit on the small drawer, which serves as a writing table.

Question 4. *Are the table tops too low for the pupils when standing and working experiments at the table?*

No. This height was adopted after much investigation and experimentation, and it is found to be entirely satisfactory even for as wide a range as eighth-grade pupils up to adults.

Eighty-six per cent (65 schools) state *no* and twelve per cent (9 schools) *yes*.

Question 5. *What provisions, if any, are made for the pupils of different heights?*

In the proposed installation no provision is made for differences in stature so far as height of the tables is concerned. However, it would be relatively easy for any school to secure these tables with different heights at a slight additional cost. If students worked in a standing position several hours, day after day, this matter would be important, but under ordinary working conditions in high schools it is not a matter that requires any particular attention.

Eighty-one per cent (61 schools) state that no provision is made, and three per cent (2 schools) state that they cut the legs off chairs to suit the

needs of pupils. Five per cent (4 schools) state that chairs have footrests. One states that the footrest is turned back out of the way for the tallest students.

Question 6. *Is the space between tables too narrow for a working space for pupils?*

In a room twenty-four feet in width there is ample working space between tables, especially if not more than twenty-four to thirty students are put in one room. Where the room is only twenty-two feet in width, the aisle next to the windows should be made as narrow as possible; since there are only four to six pupils concerned in the average installation on that side of the room, this will permit a wide aisle in the center and one on the other side of the room.

Ninety-four per cent (71 schools) state *no* and seven per cent (5 schools) *yes*.

One states *yes* for the heavier student.

Question 7. *Would it be feasible to use this type of table for pupils working in groups of four on one experiment as per sketch?*

On many occasions it is possible to have four pupils work with one set of apparatus by seating two students on each side of the transverse member of the table and placing the apparatus between the two groups. This cannot be done very readily when the reagent rack is mounted permanently on the table top, but reagent trays can be installed so that they can be immediately removed from the table top when desired.

Forty-eight per cent state *yes* and thirty per cent state *no*. (On this and some other questions not all teachers replied to the question.)

Question 8. *Working in groups of two?*

Consider that the pupils can work across the sink from each other; or can be seated at the tables and work across the transverse member together; or be seated opposite each other across the transverse member and it will be seen that this T-shaped table provides the greatest flexibility for group work.

Sixty-seven per cent (50 schools) state *yes* and eleven per cent (8 schools) *no*.

Question 9. *When pupils are working individually on experiments, do those at one working space fear that acids may be spurted on their backs from test tubes of those directly behind them?*

The answer to this question is no. In all modern chemistry courses, pupils are taught that test tubes which are being heated are always to be pointed away from persons nearby. As a matter of fact, careful study will show that this method of arranging pupils gives more freedom from this particular possibility than the ordinary conventional chemistry desk does where four, six, or eight pupils stand side by side across the table from a similar group of students.

Eighty-nine per cent (67 schools) state *no* and four per cent (3 schools) *yes*.

Question 10. *How does the cost of installation compare with the separate laboratory and classroom arrangement designed to accommodate the same number of students?*

Cost comparisons are given in detail in this paper.

Question 11. *Is the working space on the table top large enough for each student?*

Computation will show that the working space per pupil is twenty-five per cent more than that available on the conventional type of laboratory table.

Ninety-six per cent (72 schools) state *yes* and only one school states *no*.

Question 12. *Is there ample cabinet and drawer space?*

The answer to this question depends a great deal on the particular conditions that prevail in a given school.

Eighty-six per cent (65 schools) state *yes* and thirteen per cent (10 schools) state *no*.

Question 13. *It is objected that the arrangement of the tables will make it inconvenient for the instructor to move about among the students as they work at their laboratory desks. Do you as a teacher experience this inconvenience?*

This type of installation is planned primarily to eliminate the inconvenient floor plans now used in so many schools. In the first place all of the students face the instructor in demonstration or laboratory work. This makes for a very much better control of the class as all experienced teachers will agree. Secondly, the teacher can stand in the middle of the room and no pupil will be farther than twelve feet away from him.

Eighty-one per cent (61 schools) state *no* and twelve per cent (9 schools) state *yes*.

Question 14. *It is argued that the arrangement of the tables will make for an unnecessary or unusual number of accidents to reagent bottles and apparatus. Have you found this to be true?*

No, for the simple reason that a much more careful supervision of pupils is possible with this type of floor plan. When the chair is placed under the transverse member of the table the working space is immediately converted into the type of table required for individual experimentation. If the reagent bottles are kept in the middle of the table, as they usually are, there is no more handling of reagents with this type of equipment than with any other type of equipment. Furthermore, there is no reaching over the apparatus of a neighboring pupil in order to secure a particular bottle as is true with many conventional tables.

Ninety-three per cent (70 schools) state *no* and three per cent (2 schools) *yes*.

Question 15. *Is the laboratory room large enough to accommodate, without undue interference, twenty pupils at one time?*

Ninety per cent of the schools (63 schools) state *yes* and eight per cent (6 schools) *no*.

Question 16. *Do you consider the T-type of laboratory arrangement to be superior to the plan in which the pupils' laboratory tables are located in the rear, the instructor's demonstration table at the front end of the laboratory, and a group of armchairs or other seating equipment located between the demonstration table and the pupils' working tables? If so, please state the significant advantages that you find.*

The armchair arrangement of laboratory is open to the following objections: (1) The armchair is not a writing desk and cannot be successfully used as such. The high school inherited this type of equipment from the university when students attended lectures and took notes. This particular type of teaching is rapidly being abolished in the better high schools and the presumption is that armchairs are no longer looked upon with the favor they once had. (2) The pupil cannot write or make drawings or consult reference books comfortably when seated in an armchair. (3) This type of arrangement does not provide any satisfactory horizontal working surface for reading, writing, or drawing, even at the laboratory tables. Considering even that stools may be provided for these tables, this type of room provides for laboratory work in the standing position and observational work in seated position near the demonstration table. However, it does not provide for a wide range of work now regarded as necessary in carrying out what the best modern educational philosophy has to say about high-school science teaching. In the best schools pupils experiment when they need to; they write their reports, make drawings, consult reference books, sometimes do all of these during one period; it may be necessary to have demonstration work during the same period. This type of teaching can be done successfully only when pupils have a place to work so that it is not necessary to shift the class around over the room half a dozen times during the course of one period.

Sixty-six per cent (50 schools) state *yes* and sixteen per cent (12 schools) *no*.

Question 17. *Indicate the use of drawers and cabinets.*

(Omitted in this summary.)

Question 18. *Is there sufficient storage space for the individual apparatus commonly used by the pupils in general science, biology, chemistry, and physics?*

With the four drawers in the sink section of the table one drawer serves for chemistry; one drawer for physics; one for general science; and one for biology. Other divisions are suggested above.

Fifty-six per cent (42 schools) state *yes* and twenty-four per cent (18 schools) state *no*. As in other questions not all teachers replied here.

Question 19. *Is a door necessary for the recess where the reagent bottles are kept?*

In our judgment the recess near the sink should not be used for reagent bottles unless absolutely necessary and then a door should be provided which has a lock on it.

Twenty-seven per cent (20 schools) state *no* and forty-one per cent (31 schools) state *yes*.

Question 20. *The statement is made that the table shown in Figure 9 is too dirty for the use of other classes after a section in chemistry has had laboratory work. Is this true?*

The question of how dirty a laboratory may be lies largely with the instructor. Classes are inclined to be as careless as they are permitted to be. Each locker should be provided with two yards of cheese-cloth and each sink with a large sponge. At the close of a laboratory period involving messy or sloppy work, pupils can be instructed to clean the table top first with a clean moist sponge. After this the water should be wiped off with the cheese-cloth and the cloth spread over the glassware in the locker. The slight amount of moisture left on the table top evaporates in a very short time.

Sixty-three per cent (47 schools) state *no* and seven per cent (5 schools) state *yes*.

Question 21. *Is it difficult to supervise the work of the individual pupil in this type of installation, since the instructor can only supervise from the middle or outside aisles?*

Eighty-one per cent (61 schools) state *no* and thirteen per cent (10 schools) state *yes*.

Question 22. *Does this type of installation require an undue amount of walking on the part of the instructor in supervising the work of the individual pupil, since the space between each pupil's desk is closed up so the teacher cannot pass across from one desk to another?*

The general compact arrangement of this type of installation, together with the fact that pupils face in one direction and have a definite place to work, enables the instructor to handle the class with far less walking than is customary with the long tables having high reagent shelves in the middle.

Sixty-three per cent (47 schools) state *no* and fifteen per cent (11 schools) state *yes*.

Question 23. *If side wall hoods are used please state about how often in the course of the school year the pupils use these hoods.*

Nine state that hoods are used two to four times per year. Thirteen state that hoods are used five to eight times per year. Six state that hoods are used eight to twelve times per year. Two state that hoods are used fifteen to twenty times per year.

Question 24. *How do you distribute special chemicals and apparatus to students?*

One school reports as follows:

During the first three months of the chemistry course all chemicals are distributed from the demonstration table in the front of the room under the supervision of the instructor. It is found by experience that it is easier to teach pupils correctly what chemicals to use, how much of each to use, and how to transfer from one bottle to another if they do the work immediately in front of the teacher across the demonstration table. A large demonstration table is used and during the early part of the period it serves as a counter from which the pupils receive the necessary chemicals and any glassware which they must borrow. During the remainder of the year one-half of the class is assigned to the reagent bottles in the rear of the room and the other half of the class to a set of reagent bottles near the demonstration table. This relieves the congestion around the usual reagent shelf, and also enables the teacher to watch more closely those members of the class who are persistently inclined to handle chemicals carelessly.

Twelve teachers distribute materials from the demonstration table; eleven from the reagent shelves in the room; nine from a stock room; five by pupil assistants; four from demonstration desk and rear of room; and two from moving tables.

Question 25. *Is it necessary for a student to do an unusual amount of walking to secure special materials?*

Using the scheme of distribution described in No. 24 above, it would be necessary for a student in the middle of the room to walk a maximum distance of about twelve feet during two-thirds of the year. The distance that a student would walk depends altogether upon how the wall cases are arranged in a particular room. We have come to the conclusion that at least two, and possibly three, sets of chemicals are advisable in classes that have over twenty-four students, especially for any type of project or other work requiring the exercise of much initiative on the part of the student.

Seventy-seven per cent (58 schools) state *no* and only one school states *yes*.

General Summary and Conclusions

Briefly summarized, the combination laboratory and classroom as proposed in this investigation offers the following advantages:

1. It provides a flexible arrangement in the science room to take care of classes from six pupils up to twenty-four pupils in a particular science.
2. It meets the present needs of small classes and also makes adequate provision for economical expansion in the future.
3. It makes possible the installation of the necessary furniture for a class of six pupils and also makes provision for increasing the room capacity up to the maximum of twenty-four pupils.
4. It furnishes a plan for high schools without water, sewer, or gas connections such that these conveniences may be added later.

5. Any combination of sciences may be taught in this room. If necessary, three classes in chemistry may be accommodated.

6. It offers a science room for the small high school that can teach only one science and the room may be used for other classes, as mathematics, history, etc.

7. It provides a room for a three-year or four-year science sequence with ample storage space in each desk for the items commonly used in these science subjects.

8. It provides ample cabinet and locker space for each pupil.

9. All students face in one direction. This is considered very desirable in laboratory work.

10. It is possible to change from class to laboratory work with the least confusion and loss of time.

11. It can be used for any teaching combination that the science teacher may be called upon to handle in the small high school.

12. It provides for a greater percentage of use of the floor space each day than is now possible in the usual science installation.

13. It provides such an arrangement that the pupils may work in groups of four, two, or individually, depending upon the equipment available or the requirements of a particular experiment.

14. It is the most flexible floor plan now available.

15. It would furnish a convenient room for faculty meetings.

16. It would provide a convenient room for the preparation of lunch for community meetings in rural sections.

17. *It overcomes one of the most stubborn objections to the introduction of chemistry in the small high school in which there may be only one class of ten to twenty pupils. Most teachers still think a separate laboratory is necessary. This is impossible for most small high schools because: first, the floor space is limited; and, second, if installed the laboratory room would be idle ninety per cent of the available class time. The special room with special furniture is unnecessary and too expensive for the small high school.*

18. It provides storage facilities for all science equipment—a conservation feature sadly needed in most schools.

19. It furnishes a plan whereby the essential furniture for the classroom and apparatus room may be installed with provisions made to add later the desirable or necessary equipment as the science work expands.

20. It provides a room that may be used as a home room or study room.

21. It furnishes an ideal arrangement for supervised study or for work in science based on the contract plan, or the unit plan.

This combination classroom and laboratory which can be used seventy per cent of the available class time, on the basis of four classes in science, meeting seven periods per week, overcomes the chief objection to the introduction of more science in small high schools.

SOME RELATIONS OF AGRICULTURAL CHEMICAL RESEARCH TO NATIONAL PROSPERITY*

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There is a motto upon the seal of our Federal Department of Agriculture which reads, "Agriculture Is the Foundation of Manufactures and Commerce." The truth of this statement would hardly seem to require demonstration when we consider that agriculture not only furnishes many of the raw materials of manufactures and commerce but that it also supplies the basic needs of food and clothing for the entire population of the country. The importance of agriculture to national prosperity we can therefore accept as a fundamental axiom and the main theme of my remarks this evening is the relationship which chemical research has to the improvement of agriculture and hence to the promotion of national prosperity.

We may define agricultural chemistry as that branch of our science which treats of the composition of soils, crops, and farm animals and of the mutual chemical relations of these in so far as they concern the production of the means of human subsistence and welfare. The definition is a very comprehensive one for it includes not only much of chemistry but it touches also upon mineralogy, physics, meteorology, plant and animal physiology, mycology, and other correlated sciences. There is no field of applied chemistry which is broader in its scope or more inclusive in the circle of its numerous bearings than that pertaining to agriculture. No less than fifteen of the various subdivisions of chemistry, indicated in *Chemical Abstracts*, have a direct application to agriculture and most of the other fifteen remaining subdivisions have a very important indirect relation.

It is a commonplace observation that industrial chemistry is of paramount importance to the prosperity of the nation. It should be even more apparent that agricultural chemistry, which enters into so many operations of agriculture, should have a most important relationship to national prosperity although much less is heard now about this than was formerly the case. Eighty years ago, when Liebig, Lawes and Gilbert, and other chemists were demonstrating the great value of mineral fertilizers for increasing the yields of crops, chemistry was hailed everywhere as the chief foundation stone of agriculture. This view was maintained so successfully until the time of the establishment of agricultural experiment stations in the United States that chemists were very generally chosen as the first directors of these institutions. Chemists may be said to have had in the beginning almost a complete monopoly of agricultural research in the United States. That this appears to be no longer the case might seem to indicate that a decline had taken place in the appreciation of chemistry

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as a factor in agricultural science. What actually happened, however, was not a decline but an immense extension in the applications of chemistry to agriculture. The only difference is that these ever-widening applications are not always performed now under the name of chemistry as was done in the old days, but under such titles as agronomy, horticulture, plant physiology, or animal nutrition. The infusion of chemistry into these other sciences has gone so far that some of them might almost be considered as branches of chemistry and investigators in these subjects require a most thorough training in the fundamentals of this science.

Let us consider first some of the contributions which agricultural chemical research has made to our national prosperity and by prosperity we mean not simply the accumulation of material wealth but rather a favorable condition of the general public welfare.

In reply to a questionnaire upon the most important contributions that have been made to agricultural chemistry in the United States, submitted two years ago to a number of prominent chemists of the State Experiment Stations and of the Federal Department of Agriculture, there was a very general agreement upon five subjects among those who answered the request.

One of these subjects was the passage of State and Federal laws controlling the purity of foods, fertilizers, cattle feeds, insecticides, and the other commodities consumed or produced by agriculture. This contribution is of a regulatory character. The chemical control of the quality of agricultural commodities was, in fact, one of the first definite accomplishments of agricultural chemistry. Chemistry had no sooner demonstrated the great value of mineral fertilizers to agriculture than the markets began to be flooded with worthless products which were advertised to be of great value to the growth of crops. Liebig, who laid the foundations of agricultural chemistry, foresaw with great clearness some of the consequences of his discoveries as is shown by the following remarkable prophecy which he made in a letter written at Giessen in 1845.

> Manufactories of manure will be established, in which the farmer can obtain the most efficacious manure for all varieties of soils and plants. *Then*, no artificial manure will be sold whose exact amount of efficacious elements is not known; and this amount will be the scale for determining its value. Instead of the uncertainty of mere empiricism, all the operations of agriculture will be carried on with certainty; and instead of waiting the results of our labors with anxiety and doubt, our minds will be filled with patience and confidence.

The passage and enforcement of State laws requiring manufacturers of fertilizers to obey Liebig's injunction of stating "the exact amount of efficacious elements" in their products was one of the first problems to which American agricultural chemists under the leadership of S. W. Johnson gave their attention. They next worked for the passage of similar laws

for controlling the purity of cattle feeds and then finally of human foods, for strange as it may seem the control of the quality of the products used by man himself is always the last and most difficult to secure. These various enactments, because of the benefits which were gained for agriculture, industry, and the public welfare, have played a great part in promoting our national prosperity. The passage of the Federal Food and Drugs Act, as a result of the long, persistent efforts of H. W. Wiley and his co-workers, was mentioned in nearly all the answers to the questionnaire as an outstanding accomplishment in this field.

Another leading contribution of agricultural chemistry, which was mentioned in nearly all the responses to the questionnaire, was the development of accurate methods for the analysis of agricultural products. The work of the Association of Official Agricultural Chemists, established in 1884, was especially mentioned in this connection. The development by careful research of accurate methods of chemical analysis first made possible the establishment of those standards of purity for agricultural products which constitute the basis of all successful regulatory work. Of the individual methods of agricultural analysis developed by American chemists nearly all the responses to the questionnaire mentioned the milk test of S. M. Babcock, which, by its influence in improving dairy herds, in securing payment for milk and cream upon a fat percentage basis, in controlling the processes of manufacturing dairy products and in regulating the purity of municipal milk supplies, has been of inestimable value to the American people. There has been a growing feeling of late that the present generation of students is not well enough grounded in the art of chemical analysis. There is no better method of illustrating the economic value of this art to a class of students than by a demonstration of the Babcock test.

A third accomplishment of American agricultural chemistry that was named in most of the responses to the questionnaire was the placing of human and animal nutrition upon a scientific basis as a result of experiments obtained with the respiration calorimeter. This work, which was inaugurated by W. O. Atwater at the Connecticut Experiment Station upon human beings and afterward extended by H. P. Armsby at the Pennsylvania Experiment Station upon farm animals, has been of immense economic value to the national welfare. We have not as yet realized the full value of the epoch-making contributions which have been made by Atwater, Armsby, and their collaborators.

A fourth important contribution of agricultural chemistry, which was mentioned in a majority of the responses to the questionnaire, was the work of T. B. Osborne at the Connecticut Experiment Station upon the chemistry of the vegetable proteins. As a result of the investigations which he initiated, the great differences in the chemical composition, properties, and nutritive value of the proteins of our various crops were first clearly established.

The applications of this work have been of inestimable value to agriculture both in compounding rations for farm animals and in improving the diet of man.

A fifth leading accomplishment of American agricultural chemistry that was named in the replies to the questionnaire was the work performed at various experiment stations upon correcting the sterility of acid soils by the addition of lime. The investigations of H. J. Wheeler and his associates at the Rhode Island Experiment Station were particularly mentioned in this connection. The researches conducted upon this subject in various parts of the United States have restored many thousands of acres of barren farm lands to a high state of productivity.

The five subjects just mentioned which were named as of outstanding importance in the replies to the questionnaire bear unmistakable evidence of the important relationship of agricultural chemical research to national prosperity. The same can be said also of several other subjects which, although not specified in quite so large a number of the responses that were received, are nevertheless of sufficient importance to deserve mention. They are given as follows:

(*a*) The work of the different agricultural experiment stations upon the value of different fertilizers when applied to various farm crops. The field experiments of the late C. G. Hopkins at the Illinois Experiment Station and of the late W. Frear at the Pennsylvania Station were mentioned in this connection.

(*b*) The work which has been done in the United States by hundreds of agricultural chemists and biochemists upon the importance of vitamins in animal and human nutrition. Among the more prominent investigators named in this field were E. V. McCollum, L. B. Mendel, T. B. Osborne, H. C. Sherman, H. Steenbock, and various others.

(*c*) The work inaugurated by the late E. W. Hilgard, and since continued by many other American chemists, upon the reclamation of alkaline soils.

(*d*) The work of H. W. Wiley and other chemists of the Department of Agriculture in the development of the cane and beet sugar industries.

(*e*) The work of many American chemists upon the utilization of the by-products of various important crops. The researches of A. Behr upon the by-products of corn and of D. Wesson upon the by-products of cottonseed were cited as examples.

(*f*) The work of a large number of investigators upon the development of new insecticides, fungicides, serums, etc., for combating the devastations of the innumerable parasites which cause each year a billion or more dollars loss to American agriculture. The immense protection from the ravages of hog cholera, due to the labors of M. Dorset of the Department of Agriculture, was mentioned as an illustration.

(g) The work of F. K. Cameron, O. Schreiner, and other investigators of the Department of Agriculture upon the chemistry of soils.

The average judgment of a group of individual chemists upon the leading accomplishments of their colleagues is of course open to revision in the same way as the decisions of a committee of chemists upon the individual merits of a bundle of prize essays. Had the questionnaire upon leading accomplishments been submitted to an entirely different group it is certain that some other contributions than those mentioned would have been recognized and that the order of preference with regard to the importance of various individual pieces of work would have been changed. We may be fairly sure, however, that two-thirds of the contributions indicated, or eight out of the twelve, would be placed upon the summary of other similar questionnaires, so that the replies do enable us to name a majority of the most important American contributions to agricultural chemistry which have helped to advance the prosperity of the nation.

A survey of the Classified List of Projects of the Agricultural Experiment Stations of the United States for 1925–26, shows that of a total number of 6710 projects, some 1400, or approximately 21 per cent, involve various applications of chemistry to agriculture. Of these 1400 agricultural chemical projects 412 relate to fertilizers and fertilizer experimentation, 188 to soils and waters, 172 to animal nutrition, and 117 to human nutrition. The chemical investigations of the Experiment Stations follow as a whole the numerical order of plant nutrition, animal nutrition, and human nutrition. Human nutrition is obviously a part of animal nutrition, but man, although an animal, is neither a good nor a convenient subject for experimentation. Much of our knowledge of vitamins and of the other dietary factors essential to human welfare has been derived from experiments upon animals and, except for the different methods of preparing food for man and beast, the subjects of human and animal nutrition are frequently treated as one.

As we trace the development of agricultural chemical research in the United States we find that the various individual State Experiment Stations since the time of their establishment over forty years ago are specializing more and more in particular types of investigation. Lysimeter studies upon soils, for example, are being given particular attention at the Tennessee Station, soil acidity in Rhode Island, alkaline soils in California, vegetable proteins in Connecticut, and animal calorimetry in Pennsylvania. The selection of the special type of research by a given station is determined often by the individual training or preference of the person in charge of the chemical work, but the particular lines of investigation depend more naturally upon the predominating agricultural needs of each state. Chemical investigations upon dairy products, for example, are stressed more by New York, Wisconsin, and the other large milk-producing states, those upon flour by Minnesota and the other large wheat-growing states, those upon

cotton by the states of the South, those pertaining to sugar production by Louisiana and the beet-producing states of the West, and those upon corn by Iowa and the other large corn-producing states of the Middle West. The most active subject of agricultural chemical research in America at the present time is that of vitamins; no less than twenty-three of the State Experiment Stations are conducting investigations in this field, while other extensive research work upon the subject is being carried out in the laboratories of the Department of Agriculture and of numerous universities and other institutions.

Farmers are probably more frequently imposed upon by misleading propaganda than are the members of any other trade or profession. They are continually victimized by the persuasive salesman or the seductive circular. It may be a new rat poison, a new chicken feed, a new culture for soil inoculation, a new cream separator, a new process of pasteurization, or a new method of preserving eggs. New schemes of deception are being daily reported. In all such cases the farmer's chief defense is the protection afforded by the chemists of the State Experiment Stations.

Agricultural chemical research by the Federal Government has shown some very interesting lines of development. The first appropriation which Congress made for this purpose was in compliance with a resolution of the House of Representatives of January 25, 1830, and related to a chemical investigation upon the sugar cane and cane sugar production. It was conducted under the direction of the Secretary of the Treasury by Prof. Benjamin Silliman of Yale University, known sometimes as the Father of American Chemistry, and the report of 122 pages which he published in 1833 is a classic for it is not only the first Federal bulletin upon an agricultural subject but it is the first tangible evidence which we have of a realization by Congress of the importance of agricultural chemical research to our national prosperity.

The U. S. Commissioner of Patents began to publish in 1843 annual reports upon agriculture and to secure the coöperation of chemists in different parts of the country in writing reports upon the applications of chemistry to agriculture. In 1848 the Commissioner, under a Congressional appropriation of $1000, engaged the services of Professor Lewis C. Beck of Rutgers College to conduct a chemical research upon the breadstuffs of the United States and his report published in 1849 constitutes the first important contribution in the United States to the subject of cereal chemistry.

Prof. Beck's attitude upon the importance of such investigations to the public welfare is indicated in the preface to his report:

> My object has been to show in the simplest manner, and with as few technicalities as possible, how the value of the various breadstuffs may be determined, their injury guarded against, and their adulterations detected.

He quotes with approval the statement:

> That the neglect of Government to aid science is due, in a great measure, to the mistaken views of scientific men. They have too often overlooked or disregarded those matters which have a practical tendency, which politicians alone consider of importance. . . I thought it proper thus to announce the plan which has been adopted in these researches, to render them useful to the *many*, without attempting to make additions to the already accumulated stores of the *few*. As the people, through their representatives, have furnished the means for carrying on this work, they are entitled to receive all the benefits which are to be derived from it.

The opinion of Prof. Beck, expressed eighty years ago, that the researches for which the public money is expended shall be of a character that is useful to the people of the country at large, deserves to be inscribed in letters of gold upon the walls of every federal, state, and municipal laboratory.

We find in the reports of the Commissioners of Patents between 1842 and 1862 numerous important agricultural chemical papers upon soils, fertilizers, and crops and upon the industrial utilization of farm products, by many eminent American chemists (as L. C. Beck, J. C. Booth, T. B. Clemson, C. T. Jackson, and J. P. Norton). This work was done, however, by chemists who were not in the federal service. Various states, following the lead of Maryland in 1847, had established, as a public service measure, the office of State Agricultural Chemist, but nothing of the kind was done by the Federal Government until after the founding of the Department of Agriculture in 1862. The first chemist to be employed by this department, and the first chemist also to be employed as a regular salaried official by the United States, was Dr. C. M. Wetherill, who obtained his chemical training under Liebig at Giessen, and upon a sketch of whose life the late Dr. Edgar F. Smith was engaged at the time of his death. Dr. Wetherill's report as chemist of the department for January 1, 1863, the first and only scientific report to be submitted during the first year of the department's activities, marks the inception of agricultural chemical research by the Federal Government.

The chemistry division of the Department of Agriculture was not only the first federal agency to investigate the chemistry and technology of soils, fertilizers, cattle feeds, insecticides, and the various food products derived from cereals, sugar crops, fruits, vegetables, meats, fish, poultry, and milk, but it was the earliest to make chemical studies upon forestry products, naval stores, paper, leather, tanning materials, dyestuffs, paints, varnishes, denatured alcohol, and many other materials of industrial importance. The department's division of chemistry, as originally conceived and developed, was the agency in which all the chemical work of the government should be performed, but with the rapid expansion of scientific work in other bureaus of the various federal departments, this plan became too extensive for practical continuance. The relation of chemistry to agriculture and industry in both America and Europe had been gradually changing from that of an independent to that of a coöperating science.

An increasing need for chemists was felt in every branch of governmental service, with the result that chemical work on contract supplies, soils, road materials, forestry products, dairy products, meat products, and other commodities which had been initiated by the Bureau of Chemistry, was gradually taken over by federal agencies that were specifically charged with the investigation of these materials.

Leaving now the story of past accomplishments, let us consider briefly some of the ways in which chemistry is attempting at the present time to promote the advancement of agriculture.

In recent years our knowledge of the chemical changes which take place in the soil, as a result of tillage, irrigation, drainage, rotation of crops, and other processes has been greatly advanced in consequence of studies by lysimeters and other appliances. While agricultural chemistry has not yet advanced to the point where it can foretell the yield of a crop by a simple analysis of the soil, it can nevertheless make predictions of considerable importance and value. Only a few years ago a large $25,000,000 agricultural enterprise was launched in the island of San Domingo but it was doomed to financial failure from the very beginning because the promoters had neglected to make a chemical survey of the new land which they proposed to bring under cultivation. After spending millions of dollars in expensive preparations, the directors of this undertaking discovered to their consternation that the subsoil of their undrained fields was so heavily impregnated with salt that when irrigation was applied the crops were ruined by the transference of sodium chloride to the surface. A senior student in agricultural chemistry, had he been consulted, could have prevented so foolish an expenditure of money.

In its ultimate phase the study of soils is not simply an agricultural problem, as many suppose, but it also involves industrial and economic questions of the greatest significance, for the soil, in whatever way we consider it, is that upon which agriculture, manufactures, commerce, and all the phases of man's social life depend. Probably no other kind of research requires the correlation of so many sciences; questions of geology, mineralogy, chemistry, physics, meteorology, and biology are mutually concerned.

One of the most important problems confronting the agricultural chemist at the present time is the prevention of soil erosion. The annual losses in national wealth, which result from the washing away of soils by rains and floods, are incalculable. The maintenance of a good reserve of organic matter in the soil is found to be one of the best means of correcting erosion and agricultural chemists are now giving more and more attention to methods for increasing the humus content of soils by composting and green manuring. The Rothamsted Agricultural Experiment Station has recently developed a bacterial method for the rapid conversion of straw into a prod-

uct which is equal to barnyard manure as a restorative of organic matter to the soil. The chemistry of the organic matter in the soil, in its relationship to soil maintenance and fertility, is one of fundamental importance.

One of the most important economies which chemistry is accomplishing for agriculture at the present time is the introduction of concentrated fertilizers. Under the old system the nitrogen, potassium, and phosphorus compounds of chemical fertilizers were so diluted with inert filling substances that the farmers of the country have to pay an annual toll of many millions of dollars for extra freight, surplus bagging, and increased storage costs upon material that is wholly devoid of fertilizing value. The invention of new processes for making concentrated mixtures of the essential fertilizer salts and the development of satisfactory methods for their application to the soil will render unnecessary the use of filling substances and thus effect a considerable economy by eliminating these superfluous costs.

Another new development relates to the use of fertilizers for improving the composition, as well as the yield, of our crops. It has been found by chemists of the Department of Agriculture that applications of sodium nitrate to wheat, at the time the plant is heading, will produce an increase of one-quarter or more in the protein content of the grain. Since high protein wheat brings a considerably higher price in the market, this method in favorable seasons can be utilized by the farmer to considerable advantage.

A generation ago agricultural chemists were interested chiefly in the investigation of those more prominent organic plant and animal constituents which were grouped under the general names of carbohydrates, fats, and proteins, and of the some dozen leading elementary components which were thought to be all that were essential for plant and animal growth. It has now been ascertained that the number of these necessary elements and constituents is much larger than had hitherto been supposed. Some of these newly recognized essential components, such as the vitamins and various elements like iodine, fluorine, and manganese, occur in plants and animals only in very minute amounts. The number of elements recognized as necessary to plant and animal life is constantly increasing and it has even been suggested that man contains in his body every known chemical element, although in many cases in infinitesimal traces. As a result of these newer discoveries agricultural chemistry has been obliged to introduce greater refinements in its methods of analysis in order to determine whether these components, which occur in food in such minute quantities, are present in sufficient amounts to maintain the body in health. The importance of this is at once realized when we consider that the absence of the necessary fourteen-millionths of a gram of iodine per day in the individual diet may subject the population of a district to the dangers of goiter.

On the other hand, it is also being recognized that the dangers of an excess of certain elements in the diet have hitherto been greatly minimized. Evi-

dences of the insidious accumulative effects of such elements as lead and arsenic, when taken into the system over long periods of time, are being multiplied with the result that agricultural chemists have been obliged to consider the invention of new insecticides which shall be free from the dangers of these elements as a result of their introduction into food. It is hardly necessary to stress the importance to our national prosperity of chemical research in developing substances which shall reduce the immense losses that result to agriculture from the ravages of insects and microbes and at the same time shall produce no deleterious effect upon the health of the people.

Agricultural chemistry may also assist the farmer in helping him to prolong the life of the numerous products which he buys and sells. Millions of dollars are lost each year by the American farmer from the deterioration of agricultural products and of the leather, cloth, wood, and metal that enter into the composition of the various articles which he buys. Chemists of the Department of Agriculture have shown how these losses can be greatly reduced by suitable processes of storage, weatherproofing, and preserving. It has been held that unduly prolonging the life of manufactured articles reduces their demand, which thus results in an injury to business. But the basing of national prosperity upon wastage is a most pernicious doctrine, and the apparent detriment to industry from extending the usefulness of its commodities is more than offset by the assistance which the chemist renders in protecting the perishable raw products of agriculture from deterioration and decay.

The effects of moisture, temperature, composition of atmosphere, maturity of product, and other conditions upon the keeping qualities of agricultural commodities are now being studied intensively by chemists in many parts of the world, for the results have a most important economic bearing upon the problems of transportation and storage.

The successful marketing of agricultural products is becoming more and more a question of the application of chemistry to the demands of popular taste, disposal of surplus, and relief of shortage. The markets for particular varieties of fruits, grain, and vegetables are widened by chemical selection in the breeding of new varieties which are richer in sugar, starch, acid, or essential oil, as the public preference may determine. Chemical standards of maturity, such as have been developed in past years by the Bureau of Chemistry, determine the best time when the fruit should be picked for the market. If the sale of mature fruit is injured by a preponderance of green color, the golden yellow tint preferred by the public can be induced, as shown by the work of Denny and Chace, by exposure of the product to ethylene. If new potatoes are desired for the early market, the application of certain chemicals will eliminate the delay caused by the dormancy of the tubers used for seed, as demonstrated by Denny at the Boyce Thompson

Institute. If the market for lemons is depressed by an overabundance of fruit, the situation is corrected by utilizing the surplus for the production of citric acid, lemon oil, and pectin.

The millions of dollars of loss which result to agriculture, and to the industries which utilize the products of agriculture, from spontaneous combustion, dust explosions, and similar hazards have opened up another important sphere of usefulness to the agricultural chemist. The chemical engineers of the Department of Agriculture, by devising improved appliances for eliminating dust from threshing machines, grain elevators, and other establishments, for removing static electricity as a cause of ignition and for preventing by the use of inert gas the explosions which originate in attrition mills, have greatly reduced the losses from these causes.

With the changing habits in food and dress of the American people there is need of a readjustment in the uses which are made of agricultural products. The per capita consumption of meat and bread has diminished during the past quarter of a century while that of vegetables and sugar has increased. Changes in style have reduced the per capita demand for cotton in clothing and other instances can be cited of a similar character. Reductions in the use of agricultural materials in one direction necessitate an expansion of uses in another unless there is to be a curtailment in production. By devising improved methods of utilization, chemistry is now playing a rôle of increasing importance in creating new markets for agricultural products.

It may perhaps help us to realize more fully the important relationships of agricultural chemical research to national prosperity if we regard each farm of the United States as a chemical factory in which sunlight, water, carbon dioxide, and various inorganic salts are the raw materials, the operations of plant and animal life the chemical processes, and the products of the farm, such as grain, fruit, vegetables, cotton, sugar, poultry, milk, wool, meat, hides, etc., the final output. In comparison with the infinitely varied and complex processes of plant and animal chemistry the operations of an industrial chemical factory, such as the manufacture of sulfuric acid or sodium carbonate, are relatively simple. We have only to reflect upon the very incomplete state of our knowledge concerning the chemistry of cellulose, lignin, starch, proteins, vitamins, and the numerous other constituents of crops and animals, or concerning some of the more common processes of plant and animal life, such as photosynthesis or the production of milk in the lacteal gland, in order to realize the immense uncovered distance which agricultural chemistry has yet to travel.

Two fundamental principles, which agricultural chemistry has discovered in the one and a half centuries of its existence, are the law of the minimum and the law of diminishing returns. But these are general laws which apply as much to industry as to agriculture. The last bushel in the yield of

wheat and the last pound in the weight of a fattened steer cost the most to produce, similarly the last residue of impurities in a crystallizing salt and the last traces of gold in an ore are relatively the most expensive to remove. The laws of the same chemistry and of the same economics are operative in both agriculture and industry. If these laws are given equal play in each instance, we may expect the same equally beneficial results. But if the equal operation of these laws is interfered with, either in the one case or in the other, grave disturbances result. The agricultural chemist must become more and more a student of economics.

There is a growing realization among the general public of the great importance of agricultural chemical research to the public welfare. One indication of this interest is the recent bequest of Mrs. Hermann Frasch establishing a permanent endowment for the support of research in agricultural chemistry.

It has been estimated that farms and farm property represent approximately one-fifth of our tangible national wealth and that they pay in taxes about one-fifth of the total cost of government. Also about one-fifth of the chemists listed in "American Men of Science" are engaged in work of an agricultural-chemical nature. The proportion should be larger for there is room for great expansion in the applications of chemistry to agriculture. Excluding forestry products, approximately thirty-five per cent of the materials used in manufacturing industries (expressed in terms of value) are domestic agricultural products and over half of the industrial workers of the United States are employed in factories which utilize the raw materials of agriculture. With these impressive figures before us there can be no question of the important relationship of agricultural-chemical research to our national prosperity.

Pulverized Coal Propels Experimental Ship. That pulverized fuel can be employed successfully in marine boilers has been demonstrated by C. J. Jefferson, head of the Fuel Conservation Section, United States Shipping Board, Merchant Fleet Corporation, New York, and Commander J. J. Broshek, U. S. N., Office-in-Charge Fuel Oil Testing Plant, United States Navy, Philadelphia, in experiments carried on for the past seven years.

At the end of the war the United States Shipping Board had left on its hands a large fleet of ships, most of which were driven by steam and many of them burning coal. The efficiency of the hand-fired coal-burning boiler is rarely over 65 per cent and ordinarily much lower, and the cost of the conversion of the vessels to oil-burning boilers or to oil-using Diesel engines would be considerable, so it was determined to test the pulverized fuel scheme on them. The S. S. Mercer, a cargo vessel of 9500 tons, was fitted out with pulverizers and burners and so steamed out to sea on the first off-shore voyage of a sea-going vessel using pulverized coal as fuel. On her initial trip her efficiency was 95 per cent of that of her best voyage as an oil burner. Certain defects in the apparatus were disclosed but the method was demonstrated as safe and reliable for sea service and is recommended for small power plants on land.—*Science Service*

CHRISTIAN FRIEDRICH SCHÖNBEIN. PART II. EXPERIMENTAL LABORS

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The abnormal chemical behavior of iron after immersion in concentrated nitric acid was discovered in 1790 by James Keir, who followed still earlier observations of Bergmann. Further independent studies of this "altered" iron were made by Wetzlar, 1827, Fechner, 1828, Berzelius, 1829, and Herschell, 1833. It is not known how Schönbein's interest in this phenomenon was aroused, but at the end of 1835, he issued the first of many reports of his studies. He not only repeated the recorded experiments, but added a mass of new details concerning "passive iron," an expression introduced by him. Particularly striking was his discovery that the entire length of an iron wire became passive if one end was heated until distinctly blued, and that the passivity was communicated to other wires by contact. Ordinary iron was rendered passive if used as anode in the electrolysis of oxygen acids. From a few known facts, he built up a whole structure of new and surprising observations and thus turned attention toward the hitherto unknown professor, for his findings were so extraordinary that they were accepted only after repetition by disbelievers. Schönbein was not passive in bringing his results to the attention of the great authorities of the time, for he sent long accounts to Berzelius, Poggendorff, Arago, and Faraday. His letters were so naïve and yet so cogent that the self-introduced correspondent received replies. Faraday was especially interested, repeated some of the work, and published a tentative explanation.

> My strong impression is that the surface of the metal is oxidized or the superficial particles of the metal are in such relation to the oxygen of the electrolyte as to be equivalent to an oxidation.

This oxide film theory, whose statement also contains the nucleus of the more modern explanations involving gas charges and metal-oxygen alloys, was not immediately accepted by Schönbein who not only declared that the oxide film should be visible, but he remarked that this viewpoint robbed the phenomenon of all special interest, for one might then as well expect action of iron enclosed in a glass tube. He was more inclined to believe that the iron had been converted into a "noble" allotrope, though he specifically denied any belief in alchemical transmutation.

> If different species of atoms are capable of combining in various ways, why cannot atoms of like kind do the same and thus produce materials which will differ not only physically but chemically?

Later he wrote:

As to the cause of passivity, I do not dare to make definite statements, for I believe that the known facts are insufficient to enlighten us concerning this puzzling phenomenon.

This latter condition still obtains, for the subject is full of complications and a single explanation will probably not cover all cases.

Faraday was always adverse to entering scientific controversies and he did not choose to press the matter. He wrote to Schönbein:

One of the most valuable results in the present state of this branch of science which these experiments afford is this additional proof that voltaic electricity is due to chemical action and not to contact.

This diverted Schönbein's attention and he entered the conflict then raging between these opposing views, taking a position somewhat antagonistic to both. He opposed the contactists on the ground that they were postulating the existence of a force which could act indefinitely without being exhausted, nor could these views furnish reliable predictions as to the behavior of the materials in a voltaic combination. The chemical viewpoint was much more fruitful, but Schönbein cited many instances in which he believed current was produced without chemical action. In his opinion, the current arose from the disturbance of the chemical equilibrium set up by the tendency of chemical reaction with the necessary electrolyte, and consequently the current is occasioned by chemical attraction, but is not the result of a chemical reaction. Of course, he was attacked by the protagonists of the other theories, but his views contain ideas that have been incorporated in more modern speculations. He studied the electrical potency of combinations of a wide variety of materials including passive iron, oxides, peroxides, and he was a pioneer in the use of gases in voltaic chains. This work brought him into close contact with Grove and Faraday and he worked with them in their laboratories during a visit to England in 1839. Electrolytic investigations were a natural outgrowth of this study of voltaic cells and he developed a new theory to explain the products obtained by the electrolysis of salt solutions.

If chemists wish to acquire information about the constitution of compound bodies, they must devote their attention to electrolytic phenomena.

To the organic chemists he gave the following advice after he had subjected organic materials to the action of a current.

If we consider the important rôles played by oxygen and hydrogen in organic compounds and if we remember that these elements are easily obtained in the nascent state by means of the voltaic current, we may confidently expect that sooner or later we shall learn the conditions under which organic compounds will react with these elements if exposed to them at the instant of their separation from each other. I trust that the industrious chemists who prefer to busy themselves with the organic part of our science

may pay heed to this matter and consider it worth their while to repeat my experiments and to devise others of the same kind. They will then perhaps be convinced that the use of the voltaic cell is not only possible in many organic investigations, but it may indeed be of great value.

How long was it before this prevision of 1839 became a reality?

Studies of polarization and depolarizers led to interesting and useful findings. Especially important were the results obtained by surrounding the electrodes with oxidizing or reducing agents. The current set up by unequal heating of different portions of a solution, the variation in color exhibited by many materials when heated, are examples of the fields of interest which logically occupied his attention. Even though many of the hypotheses advanced by him were later discarded, his work invariably brought new facts to light. "His original methods of experimentation, *i. e.*, the art of putting questions to Nature in the form of well-planned experiments which compelled clear and succinct answers, the unbiased way in which he interpreted the results, his ready and rich imagination which enabled him to visualize his ideas, all these, combined with his indefatigable industry, were the factors which distinguished his work and gave his voice the ring of authority."

The peculiar odor following thunderbolts is mentioned in the Iliad and the Odyssey. Schönbein related that on two occasions, once when he was only a boy of eleven, and again in 1839, he observed a bluish haze and a phosphorus-like odor in buildings which had been recently struck by lightning. Van Marum, 1785, noted an "electrical odor" in the neighborhood of discharging electrical "machines" and Cavallo, 1782, proposed that electrified air, *aura electrica*, be used as a disinfectant. Cruickshank, in 1800, recorded a chlorine-like odor emanating from the anode during the electrolysis of dilute sulfuric acid. Isolated observations of this kind had been made by Berzelius, de la Rive, and others. "For the first recognition of ozone and description of its properties, we are indebted to the sagacity of Schönbein, to whom the entire merit of the discovery unquestionably belongs." (Andrews.) The peculiar odor permeating his poorly ventilated laboratory in which he was electrolyzing acidulated water struck his attention, and a few simple experiments demonstrated that he was dealing with a material gas and not with an action of electricity on the olfactory nerves, as had been suggested. He found the gas was only evolved at the anode; the odor persisted after the current ceased flowing; anodes of platinum or gold could be used, but not oxidizable metals or carbon; electrolytes containing reducing agents did not produce the odorous gas, and the introduction of bits of oxidizable materials, solutions of reducing agents, or heated strips of platinum or gold instantly removed the odor from flasks containing the gas. Strips of the noble metals acquired a negative charge when immersed in the product and

this polarity persisted for some time if the metal was clean, dry, and not heated. The complete agreement of these properties with those of the odorous material produced by electrical discharges convinced him of the identity of the two products.

> After making many further experiments in order to find the relation between the smell which is developed when ordinary electricity discharges from the point of a conductor in air and when water is decomposed by a voltaic current, I have finally arrived not at a complete solution of the problem, but at a point where the true cause of the electric odor can be recognized more or less clearly.

The chemical and electrical properties led Schönbein to believe that he was dealing with a material similar to the halogens, and since he could not conceive of its being an element, he concluded that it was more logical to revive the notion that the halogens are oxides of the theoretical elements murium, bromium, etc. On the advice of his colleague, W. Vischer, he proposed the name ozone (ὀζειν, I smell). He wrote to Faraday,

> It will perhaps interest you to learn on this occasion that my friend, being an excellent Greek scholar, acted the part of a god-father when I christened my child "ozone."

Grove wrote to him,

> You have got hold of a good point in the substance ozone, and I hope you will thoroughly work out the mine. By the bye, why not call it ozine as you consider it analogous to chlorine, bromine, and iodine.

Although the coining of a name was easy, Schönbein realized that the hardest part of the battle was still to come. De la Rive at first believed that the odor was due to minute particles of metal or metal oxide torn away by the discharge. Schönbein in refutation showed that rain water, precipitated during thunder showers, exhibited all the reactions of ozonized water.

> The existence of ozone can only be placed beyond doubt if it is isolated. As you (Faraday) may easily imagine, I am now in rather a feverish state, working from morning to night in my laboratory and sleeping very little at night.

His efforts were successful and in 1844 he announced the production of ozone by the slow oxidation of phosphorus. He undoubtedly was led to investigate this reaction, apparently so unrelated to the electrical methods, through the phosphorus-like odor of ozone, but the products were identical in voltaic, chemical, and physiological properties.

Schönbein contended that nitrogen was composed of ozone and hydrogen and this compound when electrolyzed or decomposed by sparking or by the action of phosphorus liberated ozone. Piria's contention that ozone was nothing but nitrous acid was easily disproved, but Schönbein was only convinced that nitrogen had nothing to do with the matter after ozone

had been produced by electrolysis of water freed from dissolved nitrogen, or by sparking pure, dry oxygen. Oxygen diluted with carbon dioxide was ozonized by phosphorus, but the presence of water seemed essential. However, Schönbein was far from ready to accept the proposal made by Marignac and de la Rive that ozone was a modified from of oxygen. He firmly believed that allotropism was confined to solid elements and the striking differences between oxygen and ozone appeared to preclude so simple an explanation. He pointed out that oxygen sparked over potassium iodide solution, which absorbs ozone, should diminish in volume, but this prediction was not verified until 1852. Schönbein now claimed that ozone was a superoxide of hydrogen and asserted that the oxygen used in the above experiment was not dry. Berzelius pointed out that the last third of the oxygen derived from heated potassium chlorate, and therefore dry, gave ozone when sparked, and in his *Jahresbericht* of 1847, he issued the edict that ozone is an allotrope of oxygen. Schönbein finally convinced himself of the absence of hydrogen in ozone. In 1849, he passed 300 liters of dry ozonized air through a hot glass tube. The ozone was destroyed but no weighable quantity of water was obtained. He was convinced but not converted.

> If ozone can actually be formed from ordinary oxygen, without the latter losing or gaining weight, then this is certainly the most remarkable fact discovered by modern chemistry.

It seems superfluous to state that Schönbein thoroughly explored the chemistry of ozone, its occurrence, its preparation, its reactions, its detection and estimation, and if some of his conclusions have been found invalid, it must be remembered that oxides of nitrogen, peroxides, ozone, and oxygen constitute a complex whose details are not all unravelled today.

Schönbein postulated that every oxidation was preceded by ozonation of the oxygen and assumed that activated oxygen was a component of many materials. The production of ozone by treatment of certain oxides with acid pointed to the pre-existence of this material in these "ozonides," a term which has since acquired another meaning. The marked oxidizing powers acquired by many oils, aldehydes, etc., when shaken with air or insolated were ascribed to ozone, but Engler showed that unstable peroxides rather than ozone were involved. Having accepted the existence of a second variety of oxygen, he now postulated a third. He wrote to Faraday:

> I suspect that there are two kinds of active oxygen, standing to each other in the relation of algebraic magnitudes of contrary signs, *i. e.*, being such as will neutralize each other into inactive oxygen, if brought together in equal quantities. Now supposing there are three kinds of oxygen, $\overset{\circ}{\oplus}$, $\overset{\circ}{\ominus}$, and O and assuming that hydrogen peroxide

$HO_2 = HO + \overset{\circ}{\oplus}$, and $PbO_2 = PbO + \overset{\circ}{\ominus}$, those peroxides on being brought into contact with one another must be catalyzed, because the $\overset{\circ}{\oplus}$ of the one neutralizes the $\overset{\circ}{\ominus}$ of the other peroxide into O, which as such can no more rest associated either with PbO or HO.—I shall place myself for some time under the guidance of this conjecture and see what can be made of it. If it leads me to the discovery of some interesting facts, I shall not feel ashamed of it, though it may turn out fallacious. We are no gods but short-sighted men and must be content with finding out a little bit of truth in wading through a sea of errors.

$\overset{\circ}{\ominus}$ represented the known variety of ozone because of the charge it conferred on platinum; $\overset{\circ}{\oplus}$, antozone, was declared to be present in hydrogen peroxide because the latter charged platinum positively. The mutual deoxidation of peroxides, the formation of either hydrogen peroxide or chlorine when peroxides were treated with hydrochloric acid are examples of the evidence by which manganese dioxide was classed as an ozonide, $MnO{\cdot}\overset{\circ}{\ominus}$, and barium peroxide, $BaO{\cdot}\overset{\circ}{\oplus}$, as an antozonide. Chlorine was written $MO{\cdot}\overset{\circ}{\ominus}$ (M = murium). The production of hydrogen peroxide during the slow oxidation of metals, phosphorus, etc., was ascribed to polarization of the oxygen, though ozone could be isolated only in a few of the cases studied. Over fifty papers dealt with these electrometric forms. Schönbein searched diligently for an antozonide from which antozone might be isolated, for he was desirous not only of proving his contention, but he emphasized the interest which would be attached to reactions between or involving the same material in different electrical states. He enthusiastically announced that he had secured antozone by crushing a variety of Bavarian fluorspar, but the final proofs were never obtained. The ozone-like odor was due either to occluded fluorine or to a hydrocarbon. The existence of antozone was maintained long after Schönbein's death and not until 1896, after years of study, did Engler and his co-workers finally convince the chemical world that antozone should be stricken from the literature.

The study of nitrification occupied Schönbein's attention for more than twenty years. Fixation of atmospheric nitrogen by both electrical and chemical means was held to involve preliminary ozonation of the oxygen. The origin of much of the nitrate in the atmosphere or in deposits was accounted for in this way, for the decay of organic matter is a slow oxidation, a type of reaction which Schönbein found to frequently yield ozone. The fog above slowly oxidizing phosphorus was found to contain not only hydrogen peroxide and ozone but also ammonium nitrite and its oxidation product, the nitrate. The nitrite was said to arise from direct combination of water and nitrogen, the phosphorus activating this element as it does oxygen. The production of nitrate by burning many materials in air, the conversion of nitrite to nitrate, the reduction of nitrate to nitrite

or to ammonia by metals or organic materials, the oxidation of ammonia by ozone or by oxygen in the presence of catalysts, the study of nitrifying organisms in putrefying urine, etc., the determination of the sensitiveness of various reagents for nitrous acid—all these chapters in his investigations are logical extensions of his basic ideas, and the mass of detailed information he collected is worthy of serious study.

The importance of oxidation in life processes led Schönbein into the field of physiological chemistry and particularly did he seek an insight into the nature of catalyzed reactions. The decomposition of hydrogen peroxide and other oxidizing agents was found to be accelerated by platinum, and by ferrous and basic lead salts, and this catalytic effect was produced by such things as potato peelings, saliva, blood, malt extract, fungi, yeasts, etc. Much of the early work in enzymes is due to Schönbein, and no history of catalysis is complete without extensive reference to his findings. Prussic acid was found to poison or paralyze these catalysts, and he sought to use this compound as a food preservative. After Schönbein's death, Liebig tried to capitalize this idea hoping that it might yield some monetary return to Schönbein's widow, but nothing practical came of these attempts. The rise of dissolved materials in filter paper interested Schönbein for a time, and his pupil, Goppelsroeder, greatly extended our knowledge of these capillary phenomena.

Schönbein's work on ozone constitutes his most important scientific achievement, but from a practical and popular standpoint, his fame rests on his recognition of the value of guncotton as a substitute for gunpowder. He regarded nitric and sulfuric acids as derivatives of hydrogen peroxide, $NO_4 + HO_2$ and $SO_2 + HO_2$, and consequently a mixture of these acids might be expected to have marked oxidizing powers, the peroxide acting as does chlorine in aqua regia. The mixed acids were allowed to react with a wide variety of materials, among them paper and cotton. The paper was parchmentized and became highly electrified when rubbed. Efforts to commercialize this product came to nothing, for the process of preparation had not been thoroughly worked out. Moreover, Schönbein's attention was entirely distracted by the more promising material resulting from the action of the mixed acids on cotton. Braconnot (1832) and Pelouze (1838) had prepared combustible products by treating starch, cotton, etc., with nitric acid, but Schönbein (1845–46) was the first to point out and investigate the ballistic properties of such materials. The name "guncotton" which he proposed, indicates the use to which he believed the "explosive cotton wool" might be put. Practical experiments involving firearms and blasting convinced him of the value of his discovery, and he recognized that at last his researches offered an opportunity for monetary return. He demonstrated his product, but kept the method of preparation secret, against the issue of a patent. A new engine of warfare

and destruction is always a matter of universal interest and the modest investigator soon found himself the center of attraction. He was besieged by all manner of individuals, both private and governmental, who sought profit for themselves or advantages for their governments. Serious chemists took up the problem, analyzed samples which Schönbein had distributed, and in July, 1846, R. Böttger, who had worked on styphnic acid with Will at Giessen and who therefore was familiar with nitrations, wrote to Schönbein that he had found the essential point in the method of preparing cellulose nitrates, namely, the use of mixed acids. Schönbein unwillingly entered into an agreement with Böttger to coöperate in the prosecution of the perfection of the invention and agreed to give him one-third of the profits derived from the sale of the rights of manufacture.

With high hopes and visions of great wealth, Schönbein went to England and through the aid of his eminent friends there was given opportunities to demonstrate the powers of his new explosive. The governmental authorities were favorably impressed. Schönbein was received by Prince Albert, and even spent a short time at the Queen's residence, "Osborne House," though Her Majesty did not attend the demonstration. In spite of many promises, no real progress was made toward a conclusion of the protracted negotiations and Schönbein grew homesick and discouraged. He wrote to his wife:

> The pursuit of honors and wealth are passions which bring one's soul neither satisfaction nor repose. In a short time, I seem to have become another person; the things on which I set so high a value are now matters of indifference to me. I am heartily sick of the bustling of this world in which I do not belong. My deepest desire is to return to you and the children and to get back to my modest domain where I can lead a calm existence.

The private powder manufacturers were convinced of the merit of Schönbein's patented explosive and in October, 1846, he sold the rights to Hall and Son. They agreed to pay him one-third the profits, guaranteeing £1000 annually for the first three years. Schönbein's professional salary was 2300 francs, and he returned home quite satisfied. Large scale operations were begun prematurely, and in July, 1847, a tremendous explosion destroyed the plant and killed twenty-one workers. Hall and Son repudiated its agreement and Schönbein, having neither money nor inclination to start a legal battle, accepted the situation. The American rights were sold to a Philadelphia firm, but the agent defrauded Schönbein and Böttger of two-thirds of the lump payment. The Austrian government also purchased the privilege (?) of making guncotton, but their efforts also eventuated in disastrous explosions. A like fate overtook plants in Brunswick, Dorpat, Philadelphia, and other places, and the commercial application of Schönbein's discovery had to await the studies of Nobel, Abel, etc. Immense fortunes did come from this industry, but Schönbein's return did not

exceed 100,000 francs. Thus ended his single excursion into the business world. To his wife he wrote:

> In one sense, it is a misfortune to make a discovery which has a practical importance; it disturbs your peace of mind to the utmost. Faraday and Grove tell me the same thing—they always fear when they find something which may bring them into contact with the practical world.

While studying the solubility of his mixed cellulose nitrates, Schönbein found that an ether-alcohol solution left a flexible film on evaporation. His wide-awake mind recognized the value of such a material in covering wounds. His priority in this use of "ether glue" has been questioned, but the evidence indicates that he and not Maynard of Boston is to be credited with the introduction of collodion into medicine.

The physiologist Claude Bernard wrote: "Science does not consist of facts but of the conclusions which are drawn from them." Schönbein furnished us with many facts and never hesitated to draw conclusions. He was often mistaken, for he was human, but we can rest assured that his mistakes were honest ones.

> Above all, however, the older I get, the more do I strive to become as a child, *i. e.*, to discard all schoolman's notions and man-made dogma, so that I may be able to contemplate Nature's phenomena and modes of action with an eye, unbiased and clear as possible, and take these things unto myself, free from human embellishment.

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Tanning Material Shortage Foreseen as Chestnuts Die. The leather goods industry is faced with a tremendous future shortage of tanning materials, because all chestnut trees in this country are doomed, due to the chestnut blight. This fact was presented recently to the House Appropriations Committee by Dr. C. A. Browne, Chief of Chemical and Technological Research of the U. S. Bureau of Chemistry.

At the present time, Dr. Browne said, we use in the tanning of leather thirty million dollars worth of tanning materials, of which twenty million dollars worth is produced in this country. Half of that supplied in the United States, however, comes from the chestnut.

The U. S. Bureau of Chemistry would like to begin now looking for substitutes for the chestnut in the tanning of leather. They wish to investigate the possibilities of mangrove, saw palmetto, and canaigre, for this purpose.—*Science Service*

A SYSTEM OF INDIVIDUAL REAGENTS FOR COURSES IN QUALITATIVE ANALYSIS[1]

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This paper describes in detail a system of individual reagents which has been successfully used for the past twelve years in the qualitative laboratories of the College of the City of New York. The system was devised by the author to overcome the disadvantages of the common reagent plan almost universally employed.

Disadvantages of the Common Reagent System

Where several students use the same set of reagents, though at different periods, divided responsibility for their care and upkeep is inevitable. As a consequence, many of the bottles after the first few periods are found empty or missing. The average student meets this situation by borrowing the needed reagent from some near or distant student, not without doing more or less traveling and talking. Since this procedure is followed each time a reagent is found empty or missing, it is clear that for a class working in a laboratory for three or four consecutive hours, the time wasted is considerable.

These journeys around the laboratory and the incidental conversations not only involve a great loss of time, but they seriously interfere with the close logical thinking which must always accompany good work in qualitative analysis. Many an error in a student's analysis can be traced to an interruption of his work caused by some other student seeking a missing reagent. Aside from the loss of time, and class disorder which the hunting of reagents involves, the borrowing of reagents is to be condemned on the ground that a borrowed reagent bottle may frequently be unreliable in the sense that it may contain either the wrong or an impure reagent.

In most qualitative laboratories, students are required to fill, when empty, the concentrated as well as the dilute acid and ammonia bottles. In some institutions students are expected to fill all empty desk reagent bottles from large side-shelf bottles containing stock solutions. In either case, it is not uncommon for a well-meaning student to fill some of his bottles with the wrong reagents. When this happens, every student using these misfilled bottles will get unsatisfactory analytical results and the latter will go on increasing until the supply of these reagents is either exhausted or until the sources of the reported errors are discovered.

In many laboratories side-shelf bottles are provided for those reagents which are less frequently used. This plan reduces the number of reagents on the student's desks. Under this system, the student is obliged to travel back and forth to the side shelf. In laboratories where this system is em-

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ployed, it is no uncommon occurrence for a student either to retain the side-shelf bottle at his bench or to delay its return after use. In either case, much traveling and talking are provoked. It is not unusual in such a laboratory to see a number of students running wildly about in search of a missing side-shelf reagent which some thoughtless student has locked up in his desk. Such search often involves stopping at each bench of the laboratory and closely examining each bottle for the missing reagent. When a missing bottle is located, after a long and diligent search, it is occasionally found empty and more traveling must be done and more time wasted in locating the assistant or instructor. Since there is no individual responsibility for the care of the side-shelf bottles, they are frequently contaminated by students.

The common reagent system has therefore the following disadvantages:

(1) There is no individual responsibility for a set of desk reagents; hence the set is seldom complete after the first few laboratory periods.

(2) Students finding reagent bottles empty or missing borrow the needed reagents from other students. Borrowing reagents, which becomes the universal practice, causes (*a*) considerable loss of time; (*b*) it creates considerable class disorder, seriously interfering with close analytical thinking; (*c*) it encourages the bad practice of relying on another's work in filling or preparing the needed reagent.

(3) Common reagents are unreliable because the bottles are likely to be misfilled or the reagents contaminated.

Under this system the student learns practically nothing concerning the preparation of his reagents. Many years ago when the common reagent system was in use in our laboratories, a new laboratory assistant prepared some cleaning mixture of chromic and sulfuric acids in a bottle bearing the label "Barium Chloride." He did not think it necessary to re-label the bottle since he could readily identify the mixture. But one afternoon, a student, needing some barium chloride solution and not finding any at his desk, made the customary search and locating the cleaning mixture (labeled $BaCl_2$) used some of the latter. The results were so different from those indicated in his text, that the student showed his results to the writer. The mystery was solved when the student pointed out the "$BaCl_2$" he used. This student evidently did not know that an aqueous solution of barium chloride is colorless. If he had prepared his own barium chloride solution, as he must do under the individual reagent system, he would not have made such an error.

Advantages of the Individual Reagent System

Under this system, each student is supplied with all the chemicals needed in the course, in quantities slightly in excess of his requirements. These chemicals, together with an entire set of reagent solutions which he pre-

pares, the student locks up in his desk at the end of each laboratory period. When at work, the student need never leave his desk in search of a missing reagent, for the complete set is always at his desk. Since he alone is responsible for his reagents, he sees to it that the set is always complete. If in an extreme case he should use up his entire supply of any reagent, it is not necessary for him to travel about the laboratory and disturb his fellows. He need only fill out a stock requisition slip and an additional vial containing the desired chemical can be had from the stock-keeper.

Under this system each student prepares all his reagent solutions. For this work, of course, he is supplied with adequate directions. The reagents

REAGENTS TO BE PREPARED BY THE STUDENT

Chemical	Strength	Grams in a liter of solution	Capacity of container to be used, cc.
Acid hydrochloric, dil.	3*N*	109.5	60
Acid sulfuric, dil.	3*N*	147	60
Acid nitric, dil.	3*N*	189	60
Ammonium acetate	3*N*	231	60
Ammonium carbonate	4*N*	192	200
Ammonium hydroxide, dil.	3*N*	105	60
Ammonium molybdate		*	60
Ammonium oxalate	0.5*N*	35.5	60
Ammonium sulfate	2*N*	132	60
Barium chloride	2*N*	244	60
Barium hydroxide	Sat. sol.		60
Calcium chloride	2*N*	147	30
Calcium sulfate	Sat. sol.		60
Cobalt nitrate	2*N*	291	60
Cobalt nitrate	0.3*N*		
Copper sulfate	2*N*	250	60
Ferric chloride	2*N*	180	60
Magnesia mixture		*	15
Manganese chloride	Sat. sol. in conc. HCl		30
Mercuric chloride	Sat. sol.		15
Potassium chromate	*N*	97	30
Potassium ferrocyanide	*N*	106	30
Potassium nitrite	6*N*	510	30
Potassium permanganate	*N*	31.5	15
Potassium thiocyanate	*N*	97	15
Silver nitrate	0.25*N*	42.5	60
Sodium carbonate	3*N*	159	30
Sodium cobaltic nitrite		*	15
Sodium cyanide	*N*	49	60
Sodium hydroxide	6*N*	240	200
Sodium phosphate	*N*	119	60
Stannous chloride	0.5*N*	56.5	30

* Follow special directions supplied by the instructor.

to be prepared will vary somewhat with the schemes of analyses followed.

In our laboratories the reagents prepared are listed in the preceding table together with other useful data.

In column 3 are given the amounts required for the preparation of a liter of solution of the strength indicated in column 2. The volume of the solution to be prepared by the student is obviously, in each case, identical with the volume of the container which is given in column 4. Thus, to prepare 60 cc. of 3*N* HCl, 0.06 × 109.5 g. HCl gas will be required.

Should the student make the mistake of filling his dilute HCl bottle with HNO_3 he alone will suffer, since he is the only person using this reagent. The same is true for any other mistake he might make in the preparation of his reagents.

In addition to overcoming all the disadvantages of the common reagent system, the individual reagent plan presents the following advantages:

1. The student becomes acquainted with the physical properties of the solid substances used in making reagents.
2. He is required to calculate in each case the quantity of salt needed to prepare a specified volume of a solution of definite normality.
3. By actually making up his solutions, he becomes familiar with the characteristic properties of such substances as require special treatment, such as $AgNO_3$, $(NH_4)_2CO_3$, and $SnCl_2$. This information he can learn effectively in no other way.

The Author's Individual Reagents System

General Description.—In addition to the usual chemical apparatus, each student is supplied with a specially constructed wooden rack (Figure 1) provided with shelves and capable of holding all the reagents, solids, and solutions needed in qualitative analysis. In some of our laboratories it was found more convenient to have two small racks instead of one large one. The rack is of such dimensions that it can be readily locked up in the student's locker or cupboard. The shelves are so constructed as to permit the labels on all the bottles to be plainly seen and to allow the bottles to be easily removed and replaced. Bottles of six different sizes are used, the size in each case depending upon the quantity of material needed.

The above is merely an outline of the chief features of the system. A concrete idea of the working-out of this system can only be had by noting the successive steps which the student takes in preparing his solutions and filling his rack.

At the College of the City of New York, the student obtains from the stock-keeper the following articles: (*a*) a key to a laboratory bench equipped with all the apparatus required in the course, including a wooden rack[2] (Figure 1) and a set of empty bottles for holding his reagent solutions; (*b*)

[2] The dimensions of the rack are $16^1/_4'' \times 14^1/_4'' \times 6''$.

a complete chemical kit contained in a pasteboard box[3] and consisting of the following articles:

1. A set of gummed printed labels to be used for labeling his reagent bottles.

2. A set of solid chemicals required for (*a*) the preparation of reagent solutions and (*b*) for the preliminary experiments on acids. These chemicals, together with their respective amounts and containers, are listed in the table below:

SOLID CHEMICALS

Chemical	Approx. content in g.	Container
Ammonium acetate	30	2 oz. w. m. b.
Ammonium carbonate	40	2 oz. w. m. b.
Ammonium oxalate	3	1 dram vial
Ammonium sulfate	12	4 dram vial
Barium chloride	15	4 dram vial
Barium hydroxide	3	1 dram vial
Calcium chloride	5	2 dram vial
Calcium fluoride	1	½ dram vial
Calcium sulfate	1	½ dram vial
Ferrous sulfate	1	½ dram vial
Ferrous sulfide	1	½ dram vial
Magnesium chloride	1	1 dram vial
Mercuric chloride	1	½ dram vial
Molybdic oxide	6	1 dram vial
Potassium bromide	4	½ dram vial
Potassium chromate	3	1 dram vial
Potassium ferrocyanide	0.5	1 dram vial
Potassium ferricyanide	1	½ dram vial
Potassium iodide	1	½ dram vial
Potassium nitrate	1	½ dram vial
Potassium nitrite	30	1 oz. w. m. b.
Potassium permanganate	1	½ dram vial
Potassium thiocyanate	3	½ dram vial
Silver nitrate	3	½ dram vial
Sodium chloride	2	1 dram vial
Sodium cyanide	4	2 dram vial
Sodium fluoride	1	½ dram vial
Sodium hydroxide	50	2 oz. w. m. b.
Sodium nitrite	10	4 dram vial
Sodium phosphate	15	4 dram vial
Sodium sulfite	1	½ dram vial
Sodium tartrate	1	½ dram vial
Stannous chloride	2	½ dram vial
Tin foil	2 in. sq.	2 dram vial

3. A set of test solutions. The latter are contained in one oz. cork-stoppered bottles and have a concentration of 20 mg. of metal per cc. except

[3] The dimensions of the pasteboard box are 8″ × 11″ × 5″.

lead nitrate solution which contains 50 mg. of Pb per cc. The following is a list of these test solutions:

TEST SOLUTIONS

Lead nitrate	Cobalt nitrate
Mercurous nitrate	Manganese chloride
Mercuric chloride	Zinc nitrate
Bismuth chloride	Aluminum chloride
Copper sulfate	Chromium nitrate
Cadmium nitrate	Ferric chloride
Arsenic trichloride	Strontium nitrate
Antimony trichloride	Calcium nitrate
Stannous chloride	Magnesium nitrate
Nickel nitrate	Potassium chloride

4. A set of four "known solutions," one for each of the first three groups of metals and one for Groups IV and V. These solutions are contained in one-oz. cork-stoppered bottles.

5. Miscellaneous reagents comprising solids, liquids, and special solutions. These chemicals together with their respective amounts and containers are listed in the table below.

MISCELLANEOUS REAGENTS

Chemical	Approx. quantity	Container
Acid, Acetic 6*N*	60 cc.	c. s. b.
Ammonium chloride	40 g.	2 oz. w. m. b.
Ammonium nitrate	10 g.	6 dram vial
Ammonium polysulfide	60 cc.	r. s. b. amber
Borax	1 g.	½ dram vial
Carbon tetrachloride	15 cc.	c. s. b.
Copper turnings	5 g.	½ dram vial
Dimethylglyoxime	15 cc.	c. s. b.
Hydrogen peroxide	15 cc.	c. s. b.
Iron nails	5 each	2 dram vial
Paraffin	1 cm. cube	
Paper, lead acetate	100 strips	vial
Paper, litmus, blue	100 strips	vial
Paper, litmus, red	100 strips	vial
Potassium chlorate	1 g.	1 dram vial
Sodium acetate	10 g.	4 dram vial
Sodium bismuthate	3 g.	1 dram vial
Sodium carbonate	10 g.	4 dram vial
Sodium peroxide	30 g.	6 dram vial in can
Urea	1 g.	½ dram vial
Zinc, mossy	5 g.	1 oz. w. m. b.

Preparation of Reagent Solutions and Filling the Rack

In the transfer of chemicals from the kit to the rack, as well as in the preparation of his reagent solutions, it is desirable that the student follow an

orderly and systematic procedure. To this end he is directed to carry out this work in the following successive steps.

Step 1. Consists in placing on the table top the articles shown in Figure 1. These are: *A*, the opened chemical kit; *B*, the empty rack; *C*, empty

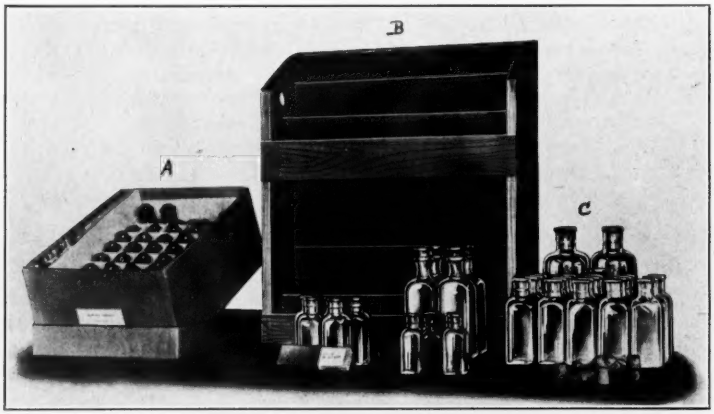


FIGURE 1

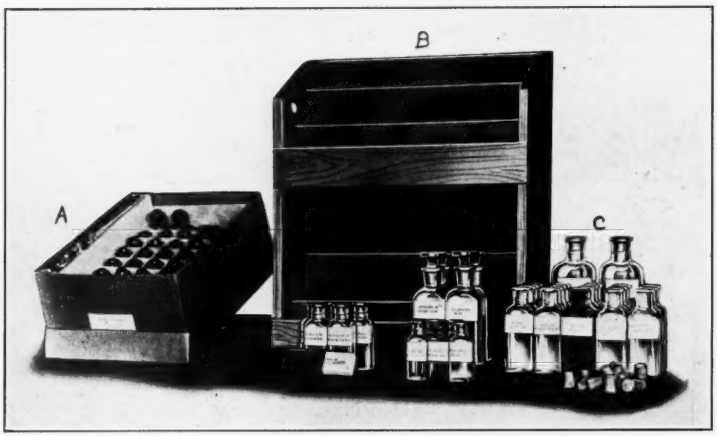


FIGURE 2

bottles for reagent solutions; *D*, a box of gummed printed labels for reagents; *E*, corks and rubber stoppers for reagent bottles.

Step 2. As shown in Figure 2, consists in placing the appropriate label on each of the empty reagent bottles.

Step 3. (See Figure 3.) Consists in carrying out the following operations:

A. The solid chemicals required for the preparation of reagent solutions are taken from the chemical kit and placed near the empty labeled reagent bottles.

B. 1. The set of test solutions are transferred from the chemical kit to their permanent places in the wooden rack.

2. Solid reagents and special liquid reagents are removed from the kit and placed in the rack in their appropriate places.

3. The concentrated acid bottles are filled and placed in the rack; the same is done with the bottle labeled conc. ammonium hydroxide.

FIGURE 3

C. Is a set of small vials containing the solids to be used for preliminary experiments on acids as well as for special experiments on metals. These vials are usually contained in a separate small box. After being checked on the printed list they are returned to the kit.

D. Is a set of known solutions. These should also be checked and returned to the kit.

Step 4. (See Figure 4.) Consists of the following operations:

1. The preparation of the reagent solutions, a list of which has been given.

2. The return to the kit of the vials containing the excess of solid reagents.

Figure 4 shows the wooden rack containing all the reagents as well as the test solutions. These, together with two eight-ounce rubber-stoppered bottles, one containing $(NH_4)_2CO_3$ and the other NaOH are always on the student's desk whenever he is at work.

Arrangement of Chemicals in Rack

To facilitate the locating of bottles and to insure their return to their proper places, it is a good plan to number each bottle. This can be done

FIGURE 4

by writing on the label the row in which the bottle is placed together with its position in that row. Thus, II 3 indicates that the bottle is in the second row from the top and is the third bottle counting from the left. An inspection of Figure 4 will show that the bottle is sodium cyanide. Likewise, VI 4 is magnesia mixture. The following is the order of chemicals in the rack. See Figure 4.

Row I. 1. Lead nitrate. 2. Mercurous nitrate. 3. Mercuric chloride. 4. Bismuth chloride. 5. Copper sulfate. 6. Cadmium nitrate. 7. Arsenic trichloride.

8. Antimony trichloride. 9. Stannous chloride. 10. Nickel nitrate. 11. Cobalt nitrate. (NOTE: These are all test solutions in 1 oz. French square c. s. b. viscose capped.)

Row II. 1. Ammonium acetate. 2. Ammonium molybdate. 3. Ammonium oxalate. 4. Ammonium sulfate. 5. Barium chloride. 6. Barium hydroxide. 7. Calcium sulfate. 8. Silver nitrate. 9. Sodium carbonate. (NOTE: These are all reagent solutions prepared by the student in 2 oz. French square c. s. b.)

Row III. 1. Ammonium hydroxide. 2. Ammonium polysulfide. 3. Sodium cyanide. 4. Sodium phosphate. 5. Calcium chloride. 6. Potassium ferrocyanide. 7. Potassium chromate. 8. Potassium nitrite. 9. Stannous chloride. 10. Ammonium chloride. (NOTE: Reagent solutions 1, 2, 3, and 4 in this row are in 2 oz. French square c. s. b.; 5, 6, 7, 8, and 9 are reagent solutions in 1 oz. French square c. s. b.; 10 is a solid reagent in 2 oz. w. m. c. s. b.)

Row IV. 1. Manganese chloride. 2. Zinc nitrate. 3. Aluminum chloride. 4. Chromium nitrate. 5. Ferric chloride. 6. Strontium nitrate. 7. Calcium nitrate. 8. Magnesium nitrate. 9. Potassium chloride. 10. Sodium peroxide. 11. Zinc (metallic). (NOTE: In this row Nos. 1–9 inclusive are test solutions in 1 oz. French square c. s. b. viscose capped; Nos. 10 and 11 are solid reagents.)

Row V. 1. Ammonium hydroxide, 15*N*. 2. Sulfuric acid, 36*N*. 3. Nitric acid, 15*N*. 4. Hydrochloric acid, 12*N*. 5. Acetic acid, 6*N*. 6. Hydrochloric acid, 3*N*. 7. Nitric acid, 3*N*. 8. Sulfuric acid, 3*N*. 9. Sodium acetate. (NOTE: Nos. 1, 2, 3, and 4 are in 4 oz. French square c. s. b.; Nos. 5, 6, 7, and 8 are in 2 oz. French square c. s. b.; No. 9 is a solid reagent.)

Row VI. 1. Carbon tetrachloride. 2. Dimethylglyoxime. 3. Hydrogen peroxide. 4. Magnesia mixture. 5. Mercuric chloride. 6. Potassium permanganate. 7. Potassium thiocyanate. 8. Sodium cobaltic nitrite. 9. Ammonium nitrate. 10. Borax. 11. Copper turnings. 12. Iron nails. 13. Lead acetate paper. 14. Litmus paper, blue. 15. Litmus paper, red. 16. Potassium chlorate. 17. Sodium bismuthate. 18. Urea. (NOTE: Nos. 1–8 inclusive are solutions in ½ oz. French square c. s. b.; Nos. 9–18 inclusive are solid reagents.)

Outside the Kit Ammonium Carbonate, Sodium hydroxide } 8 oz. round rubber-stoppered bottles n. m.

Some Possible Objections to the Individual Reagents System Considered

To those not practically familiar with this system, two serious objections are likely to be made against it. They are: (1) students lose considerable time preparing their reagents; (2) the system is costly. We shall consider each of these objections.

Consideration of Objection 1. Before the system described in this paper was adopted, the writer made a comparative study of the two systems with two classes working simultaneously though in adjoining laboratories. One class followed the old system, the other employed the individual reagent plan. The writer noted that the average time required to prepare the entire set of reagents was seven hours. This gave the other class an advantage at the start but before the end of the second fortnight the class which had apparently lost seven hours in preparing its reagents, not only

caught up to but passed those working under the old plan. The contrast in the character of the work done by both classes was striking; those under the individual reagents system working more quietly and intelligently. Moreover, this class did better work in the solution of their problems.

Consideration of Objection 2. If care is exercised to supply the student with only slightly more of each chemical than is needed, it follows that he cannot waste as much material as he generally does under the old system where an almost unlimited supply of each substance is available. Even if the student is apt to be naturally wasteful, this tendency will be curbed by a realization that he must pay for the excess chemicals he uses. For as has been already pointed out, to get an additional supply of any compound, the student under this system must fill out a requisition slip for an extra vial and this excess is charged to his account.

However, it is more costly to supply a pound of barium chloride distributed in four dram vials, each containing 15 g., than in 1 lb. lots. But the additional expense is not very great and in the writer's judgment, the slightly extra cost is more than compensated by the saving of the student's valuable time, as well as by the superior quality of the work resulting from the complete elimination of useless walking, disturbing conversation, and errors arising from the use of borrowed unreliable reagents.

New Names for Vitamin B. In the old days when vitamins were strange and little known, scientists called them, for convenience, by the letters of the alphabet. But since the vitamins have been split up into twins and triplets, the matter of names has become somewhat involved. Vitamin B, for instance, might mean any of three definite factors, according to what you were talking about. Scientific literature was becoming confused and the public was very much bewildered.

Now an effort is being made to settle the matter, as far as vitamin B is concerned. A committee of the American Society of Biological Chemists considered the matter and after deliberation has recommended three separate names for the three different factors formerly known as vitamin B.

Bios, a term suggested by British workers, is to denote the factor or factors encouraging the rapid growth of yeast cells. The antineuritic factor which is easily changed or destroyed by heat will retain the old family name of B. The more heat-stable, water-soluble, dietary factor which has to do with maintenance and growth, known also as P–P or the pellagra preventive, is to be called G.

The committee also recommended that when more vitamins or other dietary factors are discovered, they should not be given other than descriptive names, such as pellagra-preventive or antirachitic, until their identity is established beyond question.

To avoid future complications, the committee recommended that the American Society of Biological Chemists appoint a committee on vitamin nomenclature, to act in coöperation with the British and other European committees as a clearing house for information on vitamin terminology and with power to name new dietary factors when they are discovered.—*Science Service*

OF WHAT VALUE IS THE HIGH-SCHOOL COURSE IN CHEMISTRY TO THOSE STUDENTS CONTINUING THE SUBJECT IN COLLEGE?

MURRAY A. HINES, NORTHWESTERN UNIVERSITY, EVANSTON, ILLINOIS

One may start an argument at almost any gathering of chemists by proposing the question: Is the high-school course in chemistry of any value to the college student who continues the subject?

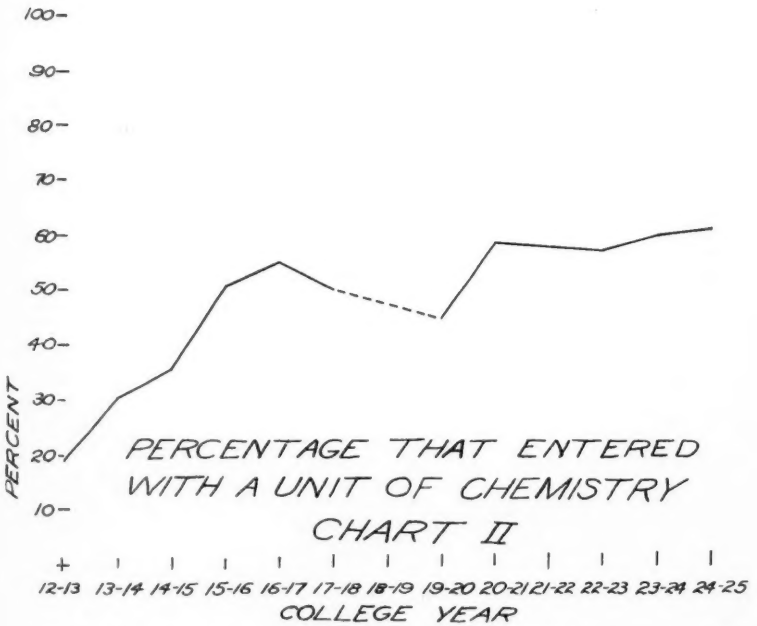
The argument usually ends in an expression of opinions on the part of the two contesting sides without any particular facts to support either side of the question. For some time I have been under the impression that facts relating to this question should exist in the records of those colleges which separate their first-year courses into two sections, one requiring and one not requiring for admission, a unit of high-school chemistry. I propose to give the facts for this college in the hope of interesting others in making comparative studies at other institutions. For several years I have collected data, relative to the performance in their college courses, of these two groups of students. I hope to present in this paper the results of this study, showing the bearing of the high-school course in chemistry upon the quality of the work done in the college courses, as well as its bearing on the chance the student has of pushing his study of the subject to the point of graduate work and degrees.

I shall attempt to answer the questions: first, is there any relationship between the high-school course and the quality of the work in college? second, does the high-school course exert a beneficial or a detrimental influence on the college work? third, does the high-school course influence the student in his choice of advanced work in college? fourth, does the content and character of the high-school course have any bearing on the college work?

General Conditions of Investigation

We will obtain a better understanding of the situation if a brief sketch is presented of the actual conditions under which the work in chemistry is given here at Northwestern. Previous to the college year, 1912–13, one course in elementary general chemistry was given at this college, including both the students entering with a unit of high-school chemistry and the students entering without any previous study of the subject. At the opening of the college year, 1912–13, we introduced a separate course of one semester for those entering with a unit of high-school chemistry. In 1919–20 this course was extended to a full year and placed on a par, as far as time assignments and credit are concerned, with the course given to students entering college without the unit in chemistry.

Students completing one of our first-year courses, mentioned above, and



There is no record for the year of the S. A. T. C., 1918–1919, as no separation was made of the first-year course into the groups under consideration.

continuing the study of chemistry go into a one-semester course in qualitative analysis, followed by a one-semester course in organic chemistry, a year course in quantitative analysis, and a year course in physical chemistry. We have here in the records made by the student in these advanced courses a means of evaluating the high-school course with regard to its effect upon the quality of the student's work in college and as it has influenced his persistence in the study of the subject.

First-Year Course

Enrolment.—The number of students in any one year is not large, but, as this study extends over a period of ten to eleven years (1912–13 through 1924–25), the results have, I believe, some semblance of recording the tendencies under consideration.

The evidence presented in Charts I and II seems to indicate a continual increase in the number of students who study chemistry in the high school and continue this study in the college.

Quality of Work.—We will now consider the record made by these two groups of students during their college course. A study of the record of the first-year courses shows that a large percentage of the students in both groups failed to make a passing grade, 60% or above, which is indicated in Chart III. Over the entire period the percentage of students passing our first-year work is 62 in the case of those students presenting a unit of chemistry for admission. It is interesting to note the slope of the curve. With the increase in numbers taking the course a smaller percentage pass the work, the figures for 1912–13 are 93% passed compared with 50% for the year 1923–24.

The corresponding figures for those without the unit of high-school chemistry are: the percentage of students passing for the entire period is 61, changing from 66 in 1912–13 to 60 in 1923–24. The slope of this curve is not as steep, indicating a more uniform performance by these students during the entire period. The greater slope of the curve in the case of those students entering with credit in chemistry may be accounted for by supposing that when the number was small only those better equipped mentally studied chemistry in the high school. With the increase in numbers of those studying chemistry in the high school, this selection of the better qualified student disappears.

A point to be made here is the almost equal percentage in the two groups of students that passed the first-year courses. This indicates a fairly uniform marking system for the two groups of students as to their ability of progress in the science. Certainly, no handicap in his choice of advanced chemical courses is placed on the student entering without a unit

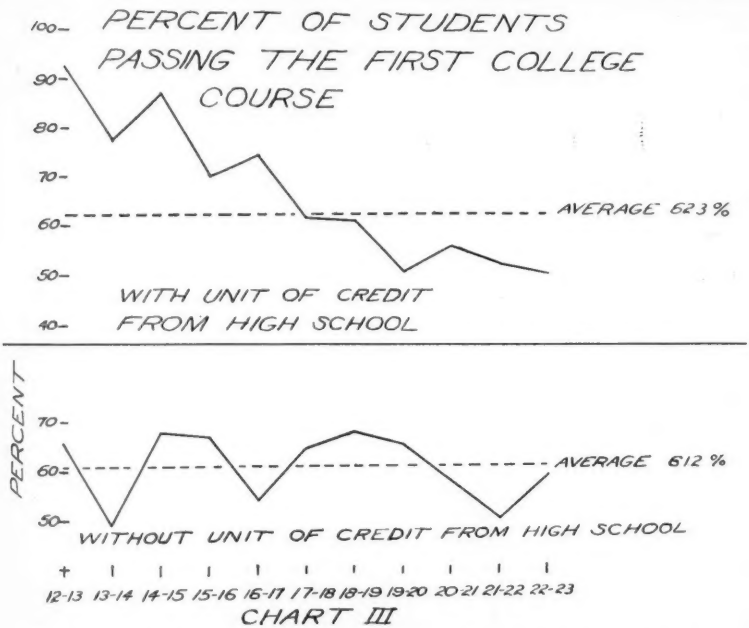


CHART III

Significance of grades: "Standing is expressed, according to proficiency, as grade *A*, *B*, *C*, *D*, *E*, or *F*. Grade *A* denotes superior scholarship; grade *B* good scholarship; grade *C*, fair scholarship; grade *D*, poor scholarship; grade *E*, a condition which may be removed by a second examination; grade *F*, a failure." On the percentage scale the letters have the following values: *A* = 90–100; *B* = 80–89; *C* = 65–79; *D* = 60–64; *E* = 50–59; *F* = 0–49.

of chemistry due to a small percentage of these students being able to carry the first year of college chemistry.

Advanced Chemical Courses

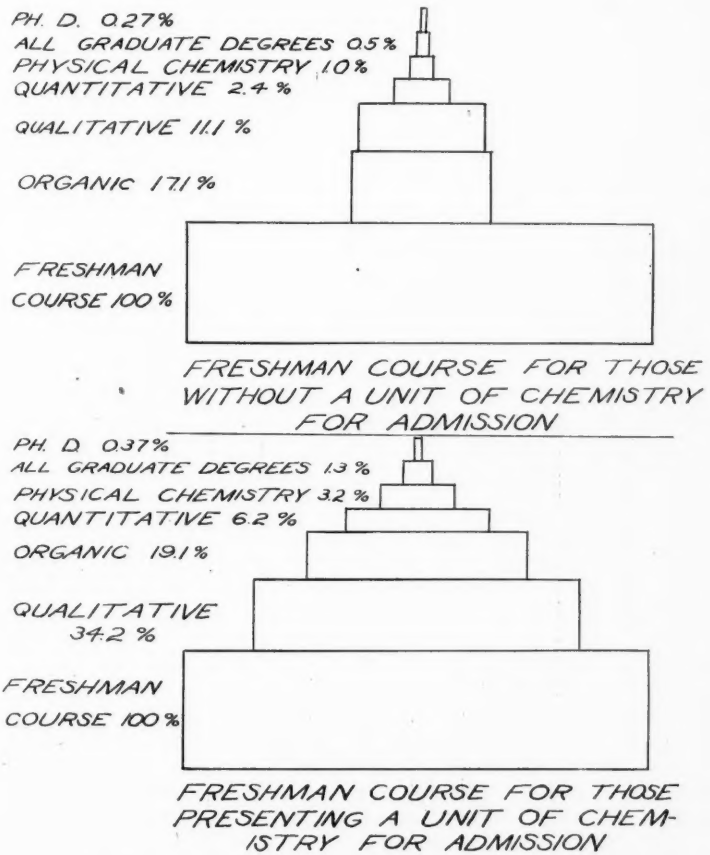
Enrolment.—The data for the second year's work show that approximately 25% of those enrolled in the first-year courses (about 40% of those passing the first-year courses) entered and completed a course in the second college year. For the third college year we find that about 4% of the first-year course completed this year's work in chemistry; in the results for the fourth college year the percentage is reduced to 2, and less than 1% of our first-year students entered upon graduate work in chemistry here or elsewhere. This is shown in Chart IV.

A comparison of the percentages of the group of students from the first-year courses that continue the work in chemistry shows that a much larger

number of students entering college with a unit of chemistry continue this subject in the advanced chemical courses than continue it from the first-year courses open to those students without high-school chemistry. The

CHART IV

PERSISTENCE IN THE STUDY OF CHEMISTRY



percentage difference becomes more noticeable in the third- and fourth-year college courses. Does this indicate that this group of students enters college with a definite plan of study for their college course?

TABLE I*

Course		Period 1912–13 through 1917–18 Total enrolment in first-year courses—1043 Group I—426 or 41.0% Group II—617 or 59.0%			Period 1919–20 through 1923–24 Total enrolment in first-year courses—1099 Group I—603 or 54.9% Group II—496 or 45.1%			Period 1912–13 through 1923–24 (omitting 1918–19) Total enrolment in first-year courses—2142 Group I—1029 or 48.0% Group II—1113 or 52.0%		
		No. students passing	%	Grade	No. students passing	%	Grade	No. students passing	%	Grade
First-year course:	I	316	74.2	60 or above	325	53.9	60 or above	641	62.3	60 or above
	II	380	61.6	60 or above	301	60.5	60 or above	681	61.2	60 or above
Qualitative:	I	237	55.6	78.0	115	19.1	78.0	352	34.2	78.0
	II	110	17.8	74.6	85	17.1	65.5	195	17.1	70.6
Organic:	I	91	21.2	80.6	106	17.6	77.8	197	19.1	79.1
	II	66	11.0	79.2	58	11.7	73.3	124	11.1	76.4
Quantitative:	I	36	8.5	82.1	20	4.2[1]	83.7	56	6.2	82.7
	II	20	3.2	84.0	4	1.0	79.1	24	2.4	83.2
Physical:	I	18	4.2	85.0	7	2.0[2]	88.6	25	3.2	86.2
	II	8	1.2	85.4	1	0.3	85.0	9	1.0	85.4
Average grade on all courses:	I			79.3			79.6			79.4
	II			77.4			75.7			76.7
Advanced degree:	I	4	0.9		6	1.7		2	0.37	
	II	4	0.6		1	0.3		2	0.27	

* In this table, Group I represents those students presenting a unit of chemistry for admission to college; Group II, those entering college without a unit of chemistry.

[1] 1919–20 to 1922–23 only. The record is yet incomplete for the full period.

[2] 1919–20 to 1921–22 only. The record is yet incomplete for the full period.

Quality of Work.—We are now prepared to consider the quality of the students' work in the advanced chemical courses. Due to the change in 1919–20 from a one-semester course to a year course for those entering with a unit of credit in chemistry, the total period under investigation will be divided into two: first, that from 1912–13 to 1917–18; and second, that from 1919–20 to 1923–24. The college year, 1918–19, is omitted from this study due to the confusion of the records during the year of the "Student Army Training Corps."

During the first period, while the semester course was in progress, 41% of our first-year students entered college with a credit in chemistry; while during the second period, 54.9% entered with a similar credit. Of the 41%, 74.2% passed the first-year college work; while of the 54.9% but 53.9% passed the year course. With the increase of 13.9% of those entering our courses open to students presenting a unit of high-school chemistry, the percentage of students passing this first-year college course dropped 20.3%.

Does this indicate a lowering of the selective influence as more and more students elect chemistry in the high school? That is, is it but another indication of the reduction of the average mental ability of our student body, due to the large increase in numbers, or does it show a tendency in the high school to give less consideration to the subject, in other words, a lowering of the standards in the high-school course?

Either view is supported when we find that, although the percentage of students entering college without the unit of chemistry, and taking chemistry in college has decreased from 59.0 in period one to 45.1 in period two, the percentage of students passing this course has decreased from 61.6 in period one to 60.5 in period two. Here a decrease in percentage of this group of first-year students of 13.9 is accompanied by a decrease of 1.1 in the percentage of students passing the course.

When we study the records, as given in Table I, made by these two groups of students in our advanced courses, we find that in the first period 55.6% of those presenting a unit of chemistry for admission to college, after completing our first-year course, entered and completed qualitative analysis, making an average grade of 78%. The corresponding data for those students beginning their chemical study in college indicate that 17.8% of the first-year course entered qualitative analysis, making a grade of 74.6%.

In the case of those students presenting a unit of chemistry for admission, the large percentage entering our second-year work during the first period is, in part, explained by the fact that the college course in first-year chemistry was of one semester's duration, and a second one-semester course was required to complete "a year of science," a requirement for a degree.[2]

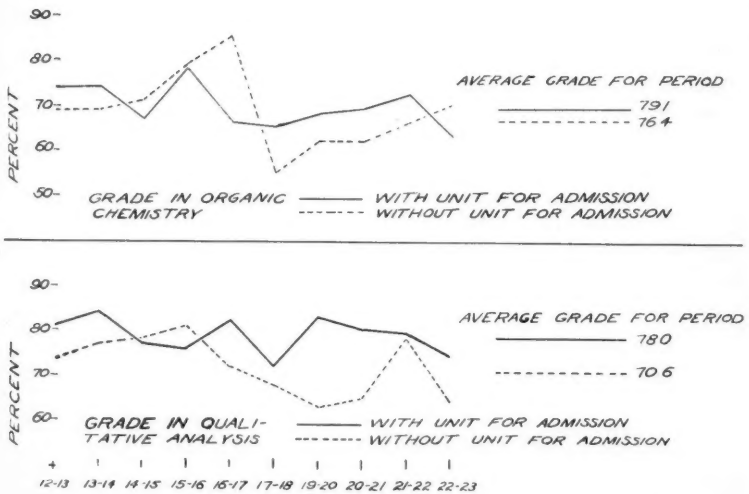
The difference, 3.4%, in the average grade obtained in qualitative analy-

[2] The requirements for a degree include: a year of one science for the degree of Bachelor of Arts; one year of each of two sciences for the degree of Bachelor of Science.

sis indicates a slight superiority in the performance of the group of students entering college with a unit of chemistry. In this connection the probability that a much greater selection of the superior student was obtained from those beginning their chemistry in college would act to increase the percentage difference if equal numbers of students had been considered.

The data for the second period indicate that when the percentage (19.1 to 17.1) and consequently the number of students continuing the study of chemistry beyond the first year is more nearly equal (115 students to 85 students), the selective influence becomes comparable, and a marked

CHART V
SECOND YEAR COURSES



superiority in performance, 12.5%, in case of the students entering with a unit of high-school chemistry is the result.

Again we note in the comparative figures for the third course, organic chemistry, for the two periods the large percentage of students continuing the subject from that group which presents a unit of chemistry for admission. Also the same group makes, when the grades are considered, a slightly better record, 1.4% in period one, 4.5% in period two, or 2.7% during the entire period of this study.

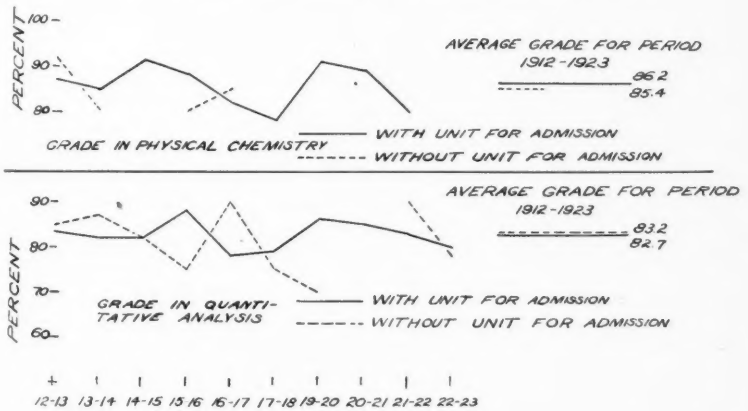
The third year of college chemistry, quantitative analysis, presents the only exception, during the first period, to the apparent rule that those students entering college with a unit of chemistry make better records in chemistry during their college course. This is, in part, explained by the

greater selection of students for here, in the third year's work, in the case of those beginning their chemistry in college, only 3.2% of those completing the first-year course take this third-year work; while 8.5% of the group completing the first-year course, composed of those entering with a unit of chemistry, complete the third year's work.

During the second period the advantage again is with those entering with a unit of chemistry, 4.2% complete the year's work with an average grade of 83.7%, compared with 1.0% of Group II making an average grade of 79.1%. In spite of the greater selective influence, the students with entrance chemistry make a grade 4.6% above the students without this unit.

Similar results are indicated for the fourth year, physical chemistry

CHART VI
THIRD AND FOURTH YEAR COURSES



The number of students is small during this year and hence the results do not have a high reliability.

When we consider the average grade in all the courses in chemistry taken after the first year, we find that during the first period (1912–17) the students entering college with a unit of credit in chemistry stand above the students of Group II by 2 points. During the second period, (1919–23) there is a difference of about 4 points in favor of the student with the unit of entrance chemistry.

If we assume, which seems justifiable, that with the decrease in percentage of either group that completes the work of any one year, a selective influence works to eliminate the weaker student, then a much greater difference in the quality of the two groups, as a whole, is apparent.

Justification of this assumption is obtained when we compare the average grade, 86.6%, made in their first-year college chemical courses by the 25 students entering with a unit of high-school chemistry and completing the fourth-year's college work, with the average grade, 91.0%, made under similar conditions by those 9 students without this unit. Here we see that the 3.2% of the group presenting a unit of chemistry for admission made a grade of 86.6% in their first-year course, compared with 1.0% of the other group making a grade of 91.0% in the corresponding first-year course. The 3.2% starting out in college with a grade of 86.6% complete the fourth-year work with a grade of 86.0%, while the 1.0% start at 91.0% and finish at 85.0%.

If these figures have any meaning, they indicate that the student studying chemistry in the high school has a better chance to make good in chemical study in college. They also show that a year's study of general chemistry in college is better than a semester for the same group, as is indicated by the increase from 2 to 4 points in the difference in grades of the two groups studied during the two periods under consideration.

Interpretation of Results

Data of this kind are open to so many interpretations and influenced by so many points outside the one of high-school chemistry, that I am tempted to point out the data and allow each reader to interpret it in his own way.

Some will explain the results by the suggestion that only the superior student elects chemistry in the high school and hence the native ability of the student accounts for the apparent higher grade of work in college courses. Others see in the added time devoted to the subject, and to the experience in and exposure to the chemical methods, a sufficient explanation of the slight difference in the average grade of the two groups. Others will see in our data a direct proof that the high-school student, having mastered the subject matter of the high-school course, is therefore better equipped to continue advanced study of the subject. This last presupposes that the high-school student retains accurate impressions and information regarding the principles of chemistry that he has acquired in his high-school course. This latter supposition is, I think, open to considerable question.

From the results of this study, combined with personal observation extending over a period of 13 years' contact with students of both groups, I am inclined to place the emphasis on the first and second explanations. I doubt if the high-school student retains very much of value as far as content of his high-school chemical course is concerned, but rather gains a scientific viewpoint from a year spent in the study of and contact with the subject of chemistry. It is quite probable that a similar scientific viewpoint could be obtained in the high school by the study of some other sci-

ence, especially physics. We might well try the experiment of admitting to the same college course, both those who present a unit of chemistry, and those who present a unit of physics, for admission to college.

These results indicate a slight superiority in performance as shown by grades for the student entering college with a unit of high-school chemistry. In this connection the greater selective influence, as shown by the smaller percentage completing the several courses, in the group not presenting a unit of chemistry tends to raise the grade of this group.

The student entering college with a unit of chemistry persists in the study of the subject for a considerably longer period than the student without this unit.

CHIEF ENGINEER, METALLURGICAL DIVISION, BUREAU OF MINES, TO BE APPOINTED

The United States Civil-Service Commission states that the position of chief engineer, Metallurgical Division, Bureau of Mines, Department of Commerce, is vacant and that in view of the importance of this position in the field of metallurgical research the method of competition will be as follows:

Instead of the usual form of civil-service examination, the qualifications of candidates will be passed upon by a special board of examiners, composed of Dr. A. C. Fieldner, Chief Engineer, Experiment Stations Division, Bureau of Mines; Dr. F. G. Cottrell, Chief of Fixed Nitrogen Research Laboratory, Department of Agriculture; Zay Jeffries, Consultant, Aluminum Company of America and General Electric Company; Dr. John Johnston, Director of the Department of Research and Technology, U. S. Steel Corporation; and Dr. A. S. Ernest, Examiner of the United States Civil-Service Commission, who will act as chairman of the committee. For the purposes of this examination, all of these men will be examiners of the Civil-Service Commission.

The entrance salary is $5600 a year. Formal applications will be received by the Civil-Service Commission until May 8th. Full information may be obtained by communicating with the United States Civil-Service Commission, Washington, D. C.

The Isotopes of Neon. In a paper which appeared in the *Philosophical Magazine* in 1920, Dr. F. W. Aston mentioned that neon appeared to possess a third isotope, of atomic mass 21, in addition to its two well-established components of masses 20 and 22, but he made no reference to this in his Bakerian lecture in 1927. T. R. Hogness and H. W. Kvalnes, who have been using the same gas to calibrate another form of mass-spectograph, now report that a peak corresponding to a singly charged ion of mass 21 invariably appears on their curves, and since they find no tracs of a peak for an ion of mass 23 which could be attributed to a hydride of Ne(22), this cannot be due to a hydride of Ne(20), and is therefore ascribed by them to the third isotope of neon. Their measurements, which have been published in the December number of the *Physical Review*, show that Ne(21) atoms are rare, constituting only about the fiftieth part of ordinary neon, and they suggest that Dr. Aston did not detect them in his later work because the high resolution of his apparatus had been partly attained at the expense of its sensitivity.— *Nature* (London), **123**, 223–4 (Feb. 9, 1929).

THE NEW ENGLAND ASSOCIATION OF CHEMISTRY TEACHERS AND HOW IT HELPS TEACHERS OF CHEMISTRY*

OCTAVIA CHAPIN, HIGH SCHOOL, MALDEN, MASSACHUSETTS

In February, 1898, the New England Association of Chemistry Teachers was established. Sixteen teachers signed the constitution and became charter members. Membership has increased so that at present it is about 400. Complete reports of all meetings are sent to members and have been since the third meeting. This fact has obtained and held teachers from such distant parts of New England, and even outside of New England, that they could not conveniently attend many meetings.

The work of the Committees has been very important. Reports from the Committee on Current Events, the Committee on New Apparatus, and the Committee on New Books are given at each meeting. Lists of books for teachers have appeared twice in the reports. In one report a list of books suitable for a Chemistry Library for Secondary Schools was published. This was probably an original idea as far as chemistry is concerned and seems to have been the forerunner of several subsequent chemistry lists from different parts of the country.

The Committee on Industrial Trips has arranged visits to industries such as those manufacturing glass, soap, candy, iron, oxygen, sugar, and acids. Various processes have been studied such as photo-engraving, lithography, and refrigeration.

The object of the association as stated in the constitution, namely, the promotion of efficient teaching in chemistry, has never been lost sight of. This aim has been accomplished by listening to papers on the teaching of chemistry in high schools and by discussions of such topics as laboratory notebooks, second-year chemistry, chemical arithmetic, etc. The practical side of chemistry has been presented by specialists. At four different times courses have been given for the help of members of the association by professors of Harvard University and Massachusetts Institute of Technology.

Five years ago a special investigation was carried on by one of the members in regard to "The Laboratory, Its Proper Function, How It Is Used and Regarded in One Hundred Schools in New England." A questionnaire was sent to about 200 schools. The tabulation and discussion of the returns made a 45-page report printed in the 25th anniversary number of the association's reports.

In 1911 the association was incorporated under the laws of Massachusetts. At this time it was voted to appoint a permanent curator of all gifts, such as books, apparatus, specimens, and lantern slides. The cura-

* Read before the Division of Chemical Education at the 76th Meeting of the A. C. S., September 12, 1928, at Swampscott, Mass.

tor is the custodian of the library and museum, collects and preserves the literature of the association, assists in the preparation and circulation of the traveling chemical exhibits, solicits teaching material of all kinds, and makes the property of the association available for its members.

The association has taken advantage of opportunities to coöperate with other organizations. At a meeting of the National Education Association in Boston, in 1903, several members read papers and the association gave a reception to President Ira Remsen of Johns Hopkins University. It has always been active in interesting its members in the affairs of the American Chemical Society and in encouraging them to join the A. C. S.

One of the most inspiring gatherings was held in conjunction with the Eastern Association of Physics Teachers in 1911. It was a reception tendered Professor Svante Arrhenius. The association is proud that Dr. Arrhenius was an honorary member and that Madame Curie, Dr. Edward Berry, Dr. Charles Herty, and several others are honorary members.

Anniversaries have been celebrated with special programs. At the fiftieth meeting Drs. Eliot, Richards, Roberts, and Talbot were the principal speakers. Dr. Newell spoke at the 25th anniversary meeting and Mr. Segerblom gave a complete report on the laboratory questionnaire. At the 100th meeting Drs. Norris and Herty were the speakers.

The New England Association of Chemistry Teachers has wished for a long time to see more associations of chemistry teachers in states outside New England, because we recognize what this would mean to the teachers of chemistry, knowing what we have derived from our own association. We therefore welcomed the organization of the Division of Chemical Education of the American Chemical Society because of the service it could render in organizing chemistry teachers throughout the country.

One factor which has spelled success for our Association has been the splendid coöperative spirit between college and high-school teachers working side by side, each getting the other's point of view, each trying to help the other. Together they have attacked the problem of the bridge between high-school and college, each correlating his work with that of the other, eliminating the gap which had kept these teachers apart, and establishing some of the "Kameraderie" which is so characteristic of the American Chemical Society as a whole.

For thirty years the association has been of value to every member because of his contact with other members, his opportunity of visiting the various industrial plants under the guidance of experts, and his opportunity of observing laboratory equipment and facilities in the various schools where meetings have been held, and of observing demonstrations of new apparatus and methods of successful teachers. Of special importance has been the summation of most of these in the reports published from time to time during the year.

TEACHING AND RESEARCH*

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In the first place I should like to call attention to the wording of the subject. It is teaching *and* research not teaching *or* research; neither is it teaching *versus* research. The two are not to be compared nor contrasted but linked together; an association of two activities, either one of which is incomplete in itself.

I think that it is both unwise and unprofitable to extol teaching as being an easier job, more desirable, more self-denying, more worthy, though less highly remunerative, than research; or to enlarge upon research as being more brilliant, more fundamental, more laborious, and therefore more highly paid than teaching. Such comparison and valuation of the two is sometimes made and usually most erroneously. The labor involved in a work and the self-sacrifice or altruism or service, or whatever you may wish to call it, that one puts into his work, and also, in most cases, the monetary reward that one obtains for it, depend not so much upon the type of work as upon the man himself. Any work is an easy job to the man who is built that way, and any work will be as exacting and exhausting and as self-sacrificing as any other if a man throws his whole life into it. Teaching and research are inseparable. The foundation of teaching is research, and the object of research is certainly teaching, that is, the diffusion of knowledge.

These are days of universal education, especially in this country, and the teaching profession has become increasingly large and important. Restricting our thoughts to our own science of chemistry, the multiplication of universities, colleges, and schools of technology, and the place of chemistry in the curriculum, not only of the university and technical school but of the ordinary college and of the secondary school, opens to a multitude of young men trained in chemistry the opportunity to take up teaching as a profession. Research, also, is no longer living a cloistered life, but is being recognized by industry, is attracting support by federal, state, and private endowments, and even finding a place in our daily newspaper.

Thus, due to their tremendous growth and development under modern conditions of society and industry, both teaching and research are tending to separate themselves from each other and to become independent professions.

In the days when Liebig built the first university laboratory for the teaching of chemistry, teaching and research together constituted a small

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unit centering about one man. The bright boy, Michael Faraday, knew that to be associated with the great Sir Humphry Davy in his investigations would, in itself, be an education and Davy, his teacher. The greatest teachers were those whose laboratories were the most prolific in investigations and to produce a series of important researches in the rapidly developing science of chemistry insured the author a position in one of the leading universities.

Thus did the relation between teaching and research become firmly established, so firmly, in fact, that no one thinks of denying it. I would be one of the last to admit that these two functions or activities should ever be separated, for I believe that the union of the two is fundamental and reaches to the very root of the life of each. As I said before, research is the foundation of teaching and also the inspiring motive force of the teacher, and the spreading of knowledge, which is simply teaching, is the only true and real object of all research.

Nevertheless, it seems to me that we have been a little too rigid and narrow in our definitions and valuations, and that modern circumstances and conditions of both teaching and research require us to broaden our views somewhat, if we are to maintain our position that the two are not independent but associated activities.

When this Chemical Society was first organized a little over fifty years ago, and for practically the first half of that period, the membership was made up largely of men in academic life. Now our members number several times what they did in 1900, and the increase is largely from the industrial side. Our journals that today are filled with the results of investigations so numerous and so far-reaching in variety and application that it is hopeless to think of "keeping up with research," have been increased largely by the products of research laboratories that have no academic connection. In this way we seem to be tending toward a divorce of research from teaching.

Is it not also true, on the other hand, that many teachers, often men of excellent ability as chemists, find, especially as the years advance and promotion in rank brings added administrative duties, that they are simply forced to give up all thought of original laboratory investigation? It has usually been true that a man, finding himself gradually losing opportunity to publish, struggles against the odds and feels that he is losing standing simply because his name does not appear frequently in the journals. Now, all this, it seems to me, is wrong. Teaching, in itself, is a work worthy of a man's best life and the whole of it. If, because of taste and talent for administration, or for the fuller intensification of the personal side of teaching itself, a young chemist finds that laboratory investigation, with the publication of results, is for him impossible, he should not be forced to feel that he is cutting himself off from standing

as a chemist, but should realize that what he is doing is contributing to the life of his science and is thus really research.

Two contending forces seem to be present in such a situation. One is the attitude of institutions and individuals, that only by published researches is a man's teaching ability to be judged and the other is the fact that, in most colleges, promotion in faculty rank means the increase of purely administrative duties, and nothing is so absorbing of time and consequently so destructive of research.

If research belongs with teaching then, certainly, our colleges and our secondary schools should recognize the fact and not make it necessary, or at least the natural course, for a man to give up ideas of research and take on administrative functions in order to satisfactorily rise in rank and salary. In our universities and sometimes in the larger colleges this fact is recognized, but often this is not the case in the run of smaller colleges and especially in our secondary schools.

Also, on the other hand, if a young man feels that administration and not research is the work in which his taste and ability lie, then this society and, in particular, this Division of Chemical Education should not fail to recognize accomplishments, other than research, that go to make teaching a full and complete task.

I have purposely been using the term research as I think it is commonly interpreted, *viz.*, as laboratory investigation and the publication of the results as an *original contribution to knowledge*. Surely to contribute even a very tiny bit to the vast store of knowledge that constitutes the science of chemistry, and to know that that bit is new to the world is an inspiring thing to do. We learned as children about "little drops of water and little grains of sand" so that however minute or special our contribution may be we are content. And we know, also, that sometimes some one, not as a mere matter of chance, but because of industry and imagination, brings forth, by research, the discoveries of new fundamental ideas that make pillars for the palace of chemistry.

Nothing is so inspiring to a student, provided he is thoroughly in earnest, as to read or be told of those original contributions to knowledge that together have resulted in the chemistry of the electron and isotopes, of colloids and synthetic dyes, and medicines. In no way can we do better, to keep pace with the interest and enthusiasm of athletics, than by helping our advanced students to actually use their own hands and their own minds to make an *original* contribution to knowledge. Having once made such a *research* the wine enters the blood and a young man goes out to take a position and nothing counts to him but research. And it is well that this is so, for I would emphasize, with all the power that my words may carry, the thought that a young man beginning his work as a chemist—whether that work may be as a teacher in a school, an assistant in a college or

university, or a routine analytical job in an experiment station or in an industrial research laboratory; wherever his training and opportunity place him, whatever his special duties may be—a young chemist should clearly realize that his freedom of time from other absorbing duties, with which freedom of time alone can he do research, this freedom of time remains his, and with rapidly diminishing value, only during the first few, perhaps ten or so, years of his active life.

I do not mean that there are no men who are able to carry on research through a long and active life, for there are, in fact, many such in our ranks today, in our universities and research laboratories. But, for the rank and file of chemists who start out with the *original contribution* that gave them their degree, in so far as they are successful in the position they fill, just in a reverse proportion does their time for research remain.

I think from all that I have said no one will doubt that I believe in the great and fundamental importance of research—*an original contribution to knowledge*—in relation to the teaching of chemistry, that it is inseparable from it.

But now I would like to make the suggestion that we broaden the meaning of the term research. And to broaden it I would shorten it by cutting out the word *original.* Also I would substitute *growth, development, or activity,* for the term *knowledge.* In other words, any contribution to the active development, growth, or real life of our science is truly research.

Interpreted in this larger way no teacher need feel that his activities prevent him from linking the word research with his teaching. If he so loves the daily routine tasks of class and laboratory work with his students, even though the students may be beginners only, surely he has a right to feel that he is contributing to the life of chemistry, for out of those he teaches there may arise some who distinctly advance the frontiers of our science by their discoveries. And, if the absorption of his time by actual class work and administrative activities leaves him only scattered free hours and hours at night in his home when, though no laboratory work is possible, he does find freedom to study, to think, and to write, surely the production of textbooks, even elementary ones, may constitute for him his contribution to the life of chemistry. To be sure, such contribution is not original, except in expression and in system, and the knowledge contained therein is fundamental and elemental in relation to the science it elucidates. The author does not push out the boundaries of chemistry, but he does enlarge and spread the influence of its activity and thus its real life.

I think that one of our college presidents fully expressed the idea that I am endeavoring to make clear when he said, in substance; that the success of members of the faculty on which promotion would be based, does not

rest only on researches published in the journals but rather upon a man's productive or constructive activity. Such activity might result in published researches, but also in such other forms as administrative work, either in the institution itself or in outside but correlated organizations or societies; enlargement of teaching through extension agencies or by writing of books or for the papers and, finally, personal work with students and in student activities. Such an enlarged view of the field of a teacher's life is surely not only inspiring to the teacher, but is based upon a broad fundamental conception of a teacher's work and, more important still, upon a broad interpretation of the term research.

It may seem that the position I am taking is paradoxical in that on the one hand I have tried to show that either teaching or research is, each in itself, a full task for any man and that modern conditions are tending, more and more, to make them separate activities; while on the other hand I am claiming that the two are inseparable. This is, indeed, just the point. Even though we admit that they are being drawn further and further apart we must hold fast to the conviction that only by remaining linked together can either one be all that it should be. If the teacher is to be more than a routine administrative officer he must, by some type of productive work, feel that he is contributing, not simply to knowledge, however worthy that may be, but to the developing life of the science of chemistry. And if research is not to lose its mark of individuality and originality, its vision for seeking for the truth, which it is in danger of doing in these days of organization and supervision and of mercenary rewards for industrial research that will make it wholly selfish; if research is to remain true to its heritage, it must keep touch with the spirit of teaching and feel that however independent it may seem to become it is, in reality, seeking the same end, *viz.*, the increase and diffusion of knowledge.

No life work has greater joy in itself than has teaching if so be the teacher loves his work. But to love it and to be content with it he must have the understanding acceptance of the worth of what he does by others who may not be living the same life, but who are devoted to the same science. All teachers of chemistry are chemists, and their contributions to the science they love are not small though they may often be intangible and difficult to evaluate. Surely they can feel that teaching and research are not, and must not, be separated either for their own sake or for the sake of chemistry itself.

WHAT IS TRUTH?*

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Is it not about time to ask this 1900-year old question of our chemistry textbooks? We surely cannot tell the whole truth for neither time nor the principles of pedagogy will permit. But can we tell the truth and nothing but the truth? At least four cases have forced themselves on my attention for a number of years and I desire to discuss each one briefly for the purpose of bringing out certain fundamental principles.

Several textbook writers state that the *standard atmospheric pressure* is the *average* pressure exerted by the atmosphere and is measured by 760 mm. of mercury at sea level and at 45 degrees latitude. Either the word *average* is used in a special sense or the statement is not the truth.

Some years ago I called the attention of one of our noted teachers and textbook writers to this error. He replied: "760 mm. is the average pressure of the atmosphere at the sea level at a latitude of 45°. Vermont is farther up than that, so, naturally, the average is not the same up there." As he would not admit his error I wrote to one of our most eminent physical chemists who wrote: "The definition of the atmosphere as equal to 760 mm. is an arbitrary convention. The value comes somewhere near the average atmospheric pressure at the sea level in the latitude of 45° but is, in strictness, not defined with reference to this average."

The average atmospheric pressure would be very difficult if not absolutely impossible to obtain. Shall it be the average for every second or hundredth second and for ten, or a hundred, or ten thousand years? None of these would be the true average. A true average could only result from measurements at infinitely small intervals and for infinite time. The value 760.000. . . . as our standard has not been so determined. "760 mm., a convention," is the truth. "760 mm., an average," is an untruth. Which shall we teach?

2. Some statements need qualification in order to be strictly accurate. Dulong and Petit's law is not expressing the truth unless the clause, "in the solid state," is included. What about Graham's law of gaseous diffusions as often stated? *Problem:* If 16 grams of oxygen diffuse through an orifice in a certain time, how many grams of hydrogen will diffuse under identical conditions? *Answer:* 4 grams. *Law:* Gases diffuse by weight at rates directly proportional to the square roots of their densities. *Problem:* If, as above, 10 liters of oxygen diffuse, how many liters of hydrogen will diffuse under identical conditions? *Answer:* 40 liters. *Law:* Gases diffuse by volume at rates inversely proportional to the square roots of their densities. The law as usually stated does not tell whether we are dealing with

* Read before the Division of Chemical Education at the 76th Meeting of the A. C. S., September 12, 1928, at Swampscott, Mass.

weight or volume and so while not, perhaps, telling an untruth, is not telling the whole truth. Would the addition of the two words, "by volume" in any way interfere with the teachableness of this law? Are we justified in leaving out these two words because we usually are interested in volumes and seldom in weights? When two words will make a statement accurate and their omission makes the meaning doubtful, are we justified in leaving out these qualifiers? Boyle's law might be too "cluttered up" for teaching if we tried to include in it all of van der Waal's deductions. However, either the textbook or the teacher, it seems to me, should briefly note its shortcomings. A teacher must always tell the truth and when it can be told simply he should try to tell the whole truth. Teaching is not more efficient when inexact. We must not follow the line of least resistance. That which is most easily taught is not necessarily the best taught.

3. Thirty years ago the equations in the textbooks for the formation of sodium bicarbonate were written:

$$NH_3 + CO_2 + NaCl + H_2O = NaHCO_3 + NH_4Cl$$

It was stated that, as the sodium bicarbonate was less soluble than the other possible salts, it was thrown down. Today many texts state that concentrated salt solutions are saturated with ammonia and carbon dioxide and that there results ammonium bicarbonate. This, they state, reacts later with the sodium chloride and forms sodium bicarbonate. Why is the ammonium salt first formed and how, and what makes the bicarbonate radical shift over to sodium later? Certainly this description of the process is not any more simple than the older one but what are the facts? Sodium bicarbonate is less soluble than ammonium bicarbonate and its heat of formation is 19,000 calories greater. Ammonia gas will precipitate sodium chloride from its saturated solution. Properly to teach the Solvay process, then, we must account for the formation of ammonium bicarbonate, provided it is formed, for its breaking up so that the sodium salt may be precipitated, and for such effects as result from different solubilities and different heats of formation. We should seek the truth with reference to these things and teach accordingly. If we do not know the truth, let's say so.

4. Mendeléeff, in his "Principles," tells how to obtain *perfectly pure salt* as follows: "a saturated solution of table salt is prepared, and hydrochloric acid gas is passed through it. This precipitates the sodium chloride which is not soluble in a strong solution of hydrochloric acid." This seems fairly simple and quite teachable. Why do we have to bring in the ions and say that the gas adds chlorine ions, which, with those present, increase the chlorine ion factor in the equation: $(Na^+) \times (Cl^-) = K$. Consequently, in order to keep K constant, the factor $[Na^+]$ must decrease and it does so by sodium ions uniting with extra chlorine ions, forming sodium

chloride molecules which are precipitated. True, this is in terms of the electrolytic dissociation theory but theories are for the purpose of generalization and the following facts cannot be brought under the *common ion principle:* saturated solutions of sodium chloride, potassium iodide, and potassium bromide are each precipitated by hydrogen chloride, hydrogen bromide, and hydrogen iodide and also by ammonia gas. I think that Mendeléeff would generalize and say that these salts are not as soluble in the strong solutions of the gases as they are in pure water, and would he not thus sufficiently explain the situation?

In the cases where there is a common ion (HCl + NaCl, HBr + KBr, and HI + KI) doubtless the *common ion principle* should be considered but when there is no common ion and we get precipitation, it is evident that our teaching must include some other factors. The three hydrogen halides are very soluble in water and cause precipitation of the salts. Ammonia gas is also very soluble in water and it, too, precipitates salts from saturated solutions of sodium chloride, potassium bromide, and potassium iodide.

A number of interesting questions come up at this point but my purpose is not to explain how these precipitations take place nor even to tell what these precipitates are. I have not stated that hydriodic acid precipitates sodium chloride nor am I sure that this acid precipitates only sodium chloride. I did state that there were precipitations. I am, however, questioning the advisability of teaching a series of phenomena in terms of a theory which cannot hold for all cases. In other words, until we know what is truth, should we state the facts as they appear and offer explanations which are not in accord with the facts? Is the *common ion effect* a teachable explanation for very strong solutions of salts which are precipitated by the addition of very soluble gases?

A teacher dislikes to call the attention of his classes to the shortcomings of the textbook. Misstatements and especially wrong and impossible explanations when brought to the attention of the pupils make them lose confidence in the text and perhaps in the teacher, too, or lead them to think that it is more or less guesswork and that "one man's guess is as good as another's." This should be avoided, if possible, and in order to eliminate some of these, perhaps minor, defects in our textbooks, this paper has been presented. After Pilate asked the question, "What is truth?" he said, "I find no fault." I, too, would prefer to be classed with the truth-seekers rather than with the fault finders.

British Output of Rayon. The British rayon industry is now producing at the rate of, roughly, 51,250,000 lb. a year, compared with 25,500,000 lb. in 1926. During 1928 there was a tendency for exports to increase and for imports to decrease, imports being now about 2 million lb. per annum compared with over 10 million lb. in 1924.—*Chem. & Ind.*, **48**, 145 (Feb. 8, 1929).

VALENCE AS DEFINED IN HIGH-SCHOOL TEXTS

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In an earlier article in the JOURNAL OF CHEMICAL EDUCATION,[1] the writer has pointed out some of the difficulties confronting high-school chemistry students as the result of careless definitions in chemistry texts and careless usage of chemical terms by both teachers and texts.

To emphasize the lack of agreement in the essentials of important definitions, the following report shows what a high-school student would find if he undertook to reënforce his knowledge of the meaning of valence after having read the definition given in his own text.

Let it be supposed that the student intended to search among other high-school chemistry texts until he found a definition which helped clarify the conception of valence he got from the definition given in his own text. The following is a tabulation of definitions taken from sixteen widely used texts:

A. The *measure of the combining ability* of an element—etc.—is called *valence.*

B. *Valence* is the *number of bonds* which an element has—etc.

C. *Valence* is the *capacity* of an element—etc.

D. *Valence* is a *number* which represents—etc.

E. *Valence* is that *property* of the element—etc.

F. *Valence* is the *power* which an element has—etc.

G. *Valence* is the *number of hydrogen atoms*—etc.

H. *Valence* is the *number of atoms of hydrogen or of chlorine*—etc.

I. *Valence is a number* which *expresses the combining capacity*—etc.

J. This *difference in holding and displacing power*—is a property—we might call *valence.*

K. *Valence* is *a number which expresses how many electrons*—etc.

L. *Valence is the combining power*—etc.

M. *Valence means* the combining power—etc.

N. *Valence is that property* of the atom *which indicates*—etc.

O. The number of atoms of *another element* that one atom of a given element can hold *is a very important property*—which has been given the name *valence.*

P. *Valence* is the *capacity of atoms* to combine with other atoms.

From all this the student would learn that valence is:

a property,
a number,
the capacity of an element,
number of hydrogen atoms,
number of hydrogen or chlorine atoms,
number of atoms of another element,
number of electrons,
difference in holding power,
measure of combining ability.

[1] THIS JOURNAL, **6**, 72–5 (Jan., 1929).

It is apparent that the further the student looks, the more bewildered he becomes. It would certainly be an extraordinary high-school student who would get from his search of high-school texts a very definite and accurate understanding of valence. Instead, he would probably conclude that there was no agreement among textbook writers as to the meaning of valence—or else that chemists do not know what valence is.

Can any one blame the student for this, in view of the fact that no two of these definitions taken from sixteen widely used texts are in exact agreement in all essential particulars?

Doesn't this show clearly that one of the pressing needs of instruction in chemistry is a standardized vocabulary? And doesn't it also show clearly that textbook writers are failing, when making definitions, to go back to fundamentals? The fact is that advances in the theoretical chemistry from 1910 to date may be clearly followed through these definitions. Some authors in revising their texts have brought their definitions up to date while others have not. Some of these definitions are fairly good but others are mere corollaries to the true definition of valence—which if it goes back to fundamentals must be based on the electronic theory of the structure of matter.

Saved Forests to Help in Saving Farm Lands. The outcry of a generation ago against a threatened famine of forest products has been justified, even though the famine did not materialize, E. A. Sherman of the U. S. Forest Service declared recently before the joint meeting of the American Forestry Association and the Florida Forestry Association at Jacksonville, Florida. The failure of the famine to make itself felt is in fact due to the effectiveness of the warning in inducing owners and public custodians of timber to take steps unthought of in the old, "flush" days, especially in the matter of fire prevention, waste elimination, and the seeking of timber substitutes.

The new task of the forest conservationist, Mr. Sherman continued, is to coöperate in the solution of the problem of soil exhaustion and erosion, which has now assumed alarming proportions.

"Our fields have been robbed of their fertility almost beyond human comprehension," he said. "Millions of acres have through our ignorance been rendered relatively worthless. Not for one moment would the citizens of any county or state under our flag permit one of its number to transfer a single acre of our territory to a foreign jurisdiction. The time is not ten years' distant when public opinion will just as relentlessly oppose permitting the economic value of a single acre to be buried in the Gulf of Mexico.

"The far-sighted thrift upon which was founded that part of the common law which places a taboo upon waste is still sufficiently inherent in our people to assure us that it will be applied as soon as the man in the street realizes the presence of that waste and its extent. He will insist upon prohibiting forms of agriculture that result in a permanent shrinkage in our total agricultural domain. Economic pressure and the pressure of public opinion will combine to exclude certain classes of land from cultivation until such time as such use justifies the investment necessary to adapt them for permanent tillage. Meanwhile such lands may serve a useful and very valuable purpose as forests. Forestry use not only safeguards the fertility of the soil from destruction, but actually contributes to its upbuilding."—*Science Service*

LIMITATIONS UPON THE UNIFICATION OF CHEMICAL NOMENCLATURE

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In October, 1927, there was held in Paris a magnificent celebration of the centenary of Marcelin Berthelot. Distinguished statesmen and scientists from the principal countries of the world participated. The contributions of chemistry to the advancement of civilization were extolled in the highest terms. The most frequently expressed sentiment was that science is universal and reveals the persistence and necessity of human collaboration. It owes its progress to contributions made by workers in all periods and of all nationalities.

In spite of the undoubted universality of science, its nomenclature is still far from uniform. It is uncertain how far it may be possible to proceed in the direction of making its language universal. Although science has no nationality it is necessary to recognize that scientists have, and, due to this, all efforts to promote accord in matters of common concern to them are subject to definite limitations. The case of the unification of nomenclature is one in which the needs of science must be weighed against those of the cultural aspects of languages.

That greater uniformity in chemical nomenclature is desirable will, no doubt, be admitted by all. It is less certain, however, that the resulting advantages will be generally conceded to be commensurate with the effort required to bring them into effect. Furthermore, there are certainly differences of opinion as to the expediency of attempts to introduce new names in place of those which have long been current in the various languages of the world. The subject is therefore one upon which it is particularly appropriate that the views of representative persons in many countries should be sought.

Toward this end an inquiry was addressed to about 150 chemists. It consisted of a general discussion of the advantages of uniformity in chemical terminology and the proposal of a particular case upon which concrete expressions of opinion were requested.

In this discussion it was recalled that science is advanced by the application and extension of previous knowledge. Each acquisition becomes a part of a great structure which gradually rises upon the foundations laid by those who have gone before. Workers in every period and of every nationality have contributed. The rate of progress depends, not only upon the intellectual attainments of individuals but upon the extent to which the discoveries made by each become known to all. Thus, the most complete dissemination of the oldest as well as of the latest knowledge is essential to

progress and every means which promotes this end serves to advance science.

This is so generally recognized that scientists have, since the earliest times, sought to make clearly and completely known to others the results of their labors. Language differences and other difficulties, especially in the beginning, have always interfered with the thoroughness with which this has been accomplished. For this reason much of the earlier knowledge was obtained independently by workers in several countries. It is consequently described in terms which vary with the language employed by each.

Later when newly established facts could be brought more rapidly to the attention of others, it became the custom for all to accept the nomenclature employed by those first recording a new observation. This rule has become so universal that it is now the exception for newly recognized substances or properties to be designated by different names in different languages. Consequently, scientific nomenclature has become more and more international as the sum total of knowledge has increased. Strangely, however, little attention has been paid to eliminating the earlier divergencies of nomenclature which are so inconsistent with later practice.

In the field of chemistry one of the most urgently needed improvements is probably the unification of the names of the earliest recognized elements. International agreement upon the symbol of each element has long since been adopted. It cannot be denied that it would also be a great advantage if the names of *all* the elements were likewise identical in every language. This, of course, is already the case for by far the larger number, but the smaller number, for which it is not true and to which the most widely divergent names are applied, are the most common and the ones to which reference is most frequently made in chemical literature.

Of all the elements at present known aluminum, argon, beryllium, calcium, cadmium, cerium, cesium, dysprosium, erbium, europium, gallium, gadolinium, helium, indium, iridium, krypton, lithium, magnesium, niobium, neon, nickel, osmium, palladium, radium, rubidium, ruthenium, scandium, samarium, strontium, terbium, thallium, thulium, vanadium, xenon, yttrium, and ytterbium have exactly the same name in the English, French, and German languages. Of these 38 elements the names of all but 5, namely, argon, krypton, neon, nickel, and xenon end in *ium*.

In addition to the above 38 elements, there are 24 more, namely, arsenic, boron, barium, bromine, chlorine, chromium, fluorine, lanthanum, manganese, molybdenum, neodymium, phosphorus, praseodymium, platinum, antimony, selenium, silicon, tantalum, thorium, titanium, uranium, zinc, and zirconium, which have identical names except for minor differences in spelling or termination.

This leaves only 18 elements which have names sufficiently different in

the several languages to make desirable an effort for their unification. Four of these, namely, bismuth (wismut) cobalt (kobalt), iodine (jod) and tungstanum (wolfram), are basically comparable and could be made uniform with only slight modifications.

The fourteen elements which have the greatest variety of names are the following:

Symbol	French name	German name	English name	Latin or early name
Ag	Argent	Silber	Silver	Argentum
Au	Or	Gold	Gold	Aurum
C	Carbone	Kohlenstoff	Carbon	Carbon
Cu	Cuivre	Kupfer	Copper	Cuprum
Fe	Fer	Eisen	Iron	Ferrum
H	Hydrogene	Wasserstoff	Hydrogen	Hydrogen
Hg	Mercure	Quecksilber	Mercury	Hydrargyrum
K	Potassium	Kalium	Potassium	Kalium
N	Azote	Stickstoff	Nitrogen	Nitrogen
Na	Sodium	Natrium	Sodium	Natrium
O	Oxygene	Sauerstoff	Oxygen	Oxygen
Pb	Plomb	Blei	Lead	Plumbum
Sn	Etain	Zinn	Tin	Stannum
S	Soufre	Schwefel	Sulfur	Sulfur

Thus, considering only the differences between the names in English, French, and German, *iron* is designated as *fer* and as *eisen; lead* as *plomb* and as *blei;* tin as *etain* and *zinn; nitrogen* as *azote* and as *stickstoff; copper* as *cuivre* and as *kupfer; oxygen* and *hydrogen* as *sauerstoff* and *wasserstoff*, respectively. In each of these cases the chemists of the three countries, when discussing the same element or its compounds, use a different name which every other chemist in the world is forced to learn. Although this is admittedly a small thing for any one person, the aggregate effort required of all chemists in this and future years is certainly worthy of consideration. The unification of the names of these 14 elements would undoubtedly cause a temporary inconvenience but the ultimate advantage to all cannot be doubted.

There is not only the economy in mental effort to learn names which must be considered, but a practical advantage which will be recognized by every one who has occasion to employ compilations of chemical data and the subject indices of journals and books of references. Thus, an alphabetical arrangement of the elements and their compounds, according to the names by which they are designated in one language, does not correspond to a similar arrangement made in accordance with the names of another language. In a German list tin would be found under Z and in a French one under E. Lead must be sought under B in a German index and under P in a French one. In order to overcome this inconvenience the initial of the symbol of the element, instead of that of its

name, is sometimes used. If all the names of the elements were made to conform strictly to their symbols, this latter plan would automatically become universal in all alphabetically arranged compendia of chemical data.

In the above discussion only the differences between the names of the same element in three languages have been considered. There is, however, a growing number of other languages in which important contributions to chemistry are being published. The chemists of Spain, Italy, the Scandinavian countries, the Balkan states, Czechoslovakia, Poland, Russia, Japan, and many other countries have names for the elements peculiar to their own language and will continue to use them, unless restrained by a desire to conform to a rule made for the advantage of all. Such a rule should certainly be that in all branches of science the nomenclature should be as universal as it is possible to make it. The chemists of those countries which are just beginning to contribute to the advancement of science should find it least difficult of all to adopt reforms of nomenclature.

Although attention has been directed only to differences between the names of the elements, there are a host of compounds which are known by quite different names in the principal languages of chemistry. For example, *cinnamic*, *succinic*, *malic*, etc., acids are known in German as *Zimtsaure*, *Bernsteinsaure*, *Apfelsaure*, *etc.* It is certainly remarkable that the names of these very familiar compounds have not been made as uniform as those of thousands of others and as uniform as are the formulas of all of them.

Another case which is striking for the apathy with which it has been received by the chemists of several countries is that of the names of the groups of compounds of special importance in biological chemistry. M. Gabriel Bertrand and his associates have still not obtained universal approval of their proposal to substitute the short, simple word *glucide* for the cumbersome and, in many languages, exceedingly unsatisfactory designation *carbohydrate.*

A diligently prosecuted effort to make all chemical names identical in all languages would not only serve chemistry, but would probably inspire those occupied in other fields of science to follow the example and thus promote international coöperation among scientists.

It is generally recognized that in translating from a foreign language, less difficulty is experienced with articles upon science than with those upon other subjects. This, of course, is due to the larger number of familiar words which are encountered. In the case of scientific writings it is usually possible with the aid of a dictionary and patience to translate from almost any language. An increase in the number of universal words will, naturally, reduce even more the effort required of scientists to acquaint themselves with the discoveries made by others.

Since science has no nationality and is the common property of all, it should certainly have a nomenclature which is universal, at least in all publications intended for scientists. Improvements in means of intellectual interchanges between men of science should keep pace with advances in physical means of communication which result from the application of scientific discoveries.

Although the general adoption of a universal language such as Esperanto appears to be difficult of realization, it is probable that progress in this direction would be greatly accelerated by concerted efforts to unify scientific terminology. Reforms of chemical nomenclature would not only advance the general movement toward an international language, but also render published abstracts, compendia, and all other chemical writings more easily intelligible to the chemists of all nations.

The preceding discussion of the subject was accompanied by a letter in which the following questions were asked:

1. Will the advantages resulting from a unification of the names of the more common elements repay the effort to accomplish this end?
2. Will such an effort arouse chauvinistic and other antagonisms rather than promote greater conciliation between the chemists of different nations?
3. What procedure should be followed in selecting international names and seeking universal approval of them?
4. The zoölogists of the world have adopted International Rules of Zoölogical Nomenclature and these are administered by an international commission. Do you think that the formulation and promulgation of International Rules of Chemical Nomenclature should be undertaken by a permanent commission?
5. Will you take part in efforts to obtain international uniformity in chemical nomenclature, if the general opinion appears to be in favor of the project?

The inquiry was sent to chemists who had attended meetings of the International Union of Pure and Applied Chemistry and to a number of others who were believed to be interested in the subject of nomenclature. Replies were received from 84 of the 144, in twenty countries, to whom the subject was submitted.

In a few cases the purpose of the inquiry was misunderstood. It was assumed that an effort in conflict with agencies already engaged in the study of reforms in nomenclature was being inaugurated. This caused Messrs. Bodenstein, Haber, Neuberg, Pflucke, Rassow, Stock, Biilman, Bjerrum, Brönsted, Sörensen, Boedtker, Pictit, and Sakurai (13) to suggest that the matter be referred to the International Union, or an authorized commission, and deterred them from expressing their individual views on the merits of the proposition itself.

In response to the first question, replies in the affirmative were received from Messrs.

J. F. Thorpe
M. Delepine
Chas. Lormand
A. Behal
J. Giral
K. Matsubara
W. Swietoslawski
L. Rolla
U. Pomilio
B. Menschutkin
E. Shilov
W. Segerblom
R. B. Moore
A. P. Mathews
H. E. Holmes
C. G. Fink
G. S. Whitby
W. T. Hall
G. A. Hulett
R. C. Wells
O. Maas
J. B. Ekeley
E. E. Reid
J. C. Olsen
R. T. Baker
E. E. Slosson
E. R. Weidlein
L. H. Baekeland
H. C. Sherman

The following gentlemen, although in sympathy with the idea, considered that it would be almost if not impossible of accomplishment:

Chas. Marie,* O. Scarpa, H. E. Howe, Chas. L. Parsons.

The following were either unreservedly opposed to the undertaking or felt that efforts toward its accomplishment would not be repaid by the advantages gained:

E. K. Rideal
J. C. Drummond
F. C. Carr
Alex. Findlay
British Federal Council for Pure and Applied Chemistry
C. S. Gibson
F. G. Donnan
T. M. Lowry
A. Harden
V. Grignard
G. Urbain
H. Wieland
W. Markwald
O. Fernandez
M. Huybrechts
Belgian National Committee
A. F. Holleman
Ernst Cohen†
F. Ullmann
N. Parravano
Prince Conti
Fritz Pregl
Y. Osaka
M. T. Bogert
E. W. Washburn
W. A. Noyes
Julius Stieglitz
A. B. Lamb
S. C. Lind
Ellwood Hendrick
Edward Bartow
W. D. Bancroft
C. P. Smyth
G. P. Baxter
A. M. Patterson
F. G. Cottrell
E. J. Crane

1. *Comments of those in favor of unification of the names of the elements:*

Swietoslawski—In selecting international names of the elements I suggest that those derived from Latin be adopted, (1) since the symbols are based on Latin names and (2) this plan will avoid chauvinistic antagonism.

Menschutkin coincides with the suggestion of Swietoslawski and adds—We consider the unification of the names of the elements to be a preliminary step to the universal international unification of the names of chemical compounds, which is most urgently needed and which must be the chief aim of the present moment.

Thorpe—It looks as if a reversion to the Latin names, especially in the case of the elements, offers the only solution.

Giral—I think that the solution will be to choose the Latin names.

Delepine—It is preferable to adopt the Latin names.

* Considers unification especially desirable for works of reference.

† Thinks consideration should be postponed until existing chauvinism abates.

Lormand—English and American chemists have adopted the metric system. It would indeed be well if the chemists of the entire world would lend themselves to adopt an international nomenclature. For a long time ammonium acetate was called spirit of Mindererus. The designation vitriol for sulfuric acid is now abandoned in the commercial domain.

Mathews—I believe science can lead the way toward a universal language, that which would unquestionably greatly facilitate international understanding and good feeling. Uniformity in scientific terms will lead, I think, to a greater uniformity in other terms and gradually little by little so change our language as to make it more international.

Reid—The loss of time in finding the same compound in indexes in different languages has long impressed and worried me... The selection (of international names) should be based on reasonable grounds, widest use, convenience, etc. Latin names or derivatives probably have the best chance of getting by.

Fink—Use as far as possible the Latin or early name and thus show no partiality. In other words, adopt the name corresponding to the abbreviation or symbol most commonly used.

Hall—The German terms Zinn, Zinc, Kalium, Kalzium are very confusing to American readers. The name Azote in French, with its symbol Az, causes trouble with American readers.

Slosson—The most that could be done by an international committee as I see it would be to point out the present inconvenience and how it could be removed by certain changes in certain words in certain languages. Then leave it to the chemists of the country concerned to adopt the reform system and promote it if they saw fit. Any effort on the part of outsiders to interfere with "the genius of the language" would be likely to be resented.

II. *Comments of those opposed to the unification of the names of the elements:*

Rideal—I consider that the case of the elements with historic names is a case apart from that of organic chemistry. I believe that atomic numbers and symbols may be international but not the names as tin, sulfur, and the like.

Drummond—I should be sorry to see the last of the good old names of historic interest.... We are a hopelessly conservative crowd.

Findlay—The names iron, fer, eisen, etc., are part of the everyday language of the particular peoples and I do not think it a practical proposition to abolish these names, nor is it advisable or feasible to separate entirely scientific usage from popular usage.

Harden—Many of the names which vary are words in common use in the various languages (tin, lead, iron) and the use of a special chemical name would only add to instead of lessening confusion.

Urbain—The questions go far beyond the specialty of the chemist and touch the foundation even of our languages. There is no question of nationalism, but it is necessary to respect the genius of each language.

Wieland—My view is based not only upon long tradition but also on the right of speech. Names such as sauerstoff, iron, argent, etc., belong not only to science but to the general public. The argument against the proposal appears to me to be less political or chauvinistic than cultural. It would, for example, be absolutely impossible in Germany to substitute oxygen for sauerstoff.

Parravano—Even if scientists could be induced to adopt new international names, one would still meet with the overwhelming opposition of the literary world.

Huybrechts—The names of these fourteen elements are almost all common names which have been incorporated for a long time in the current language of all civilized peoples... Furthermore, certain of them, such as silver, gold, and lead have acquired by extension, notably in the French language, other significations than those of metals or of chemical elements.

Ullmann—Even if new universal names were introduced it is my view that little would be gained since they would still not enable a chemist to translate from a foreign language if he did not have command of that language.

Pregl—Unification would have to overcome the difficulty that the designations of the least known elements are so firmly rooted in the various languages that they form an integral part of them. For Germans it is almost impossible to say oxygen, hydrogen, mercury, and the like in a discourse without inviting the criticism that one chooses a foreign, strange manner of expression in contradistinction to the native speech. Professor Pregl also expresses the view that the proposed unification of the names of the elements would assist very little in overcoming a general lack of knowledge of the foreign language.

Noyes—It would be just as impossible to get Frenchmen, Germans, and Englishmen to use the same name for iron as to get them to use the same name for wood, or other common substances... The number of such elements which differ is so very small, in comparison with the number of words which must be acquired in learning to read a foreign language, and the learning of them is so facilitated by the international symbols, that the difficulty must be considered as rather trifling.

Stieglitz—The difficulties of reading the main body of any article in a foreign language are enormously greater than the trivial difficulty of knowing the names of a few elements... The name of an element is of importance not only to the chemists and other scientific men in a given country but to the public as a whole. That should weigh very heavily against any effort to make these names uniform as against the very slight advantage that might result to a very few scientific people.

Lamb—I am fundamentally in favor of international uniformity in matters of this kind, and of a policy of generous give and take in order to secure it... The confusion and waste of energy resulting from the present differences in names of the chemical elements are not very serious. To eliminate the national names of the common elements would entail several generations of determined effort.

Lind—I am in sympathy with the general project but see great difficulties with reference to the common elements.... Any attempt to do so (unify the names of the common elements) would simply set up terms peculiar to science and not understood by the general public. In my opinion nothing is to be gained by this procedure.

Hendrick—Those fourteen elements with such different names in the several languages are no less than liaison bonds between chemistry and general culture. I think it would be too expensive to give them up because they have still a great deal to do in this, and in generations to come..... We know what auriferous sands are, but there is a dream quality about golden streets that we do not want to surrender... We would not give up the copper-colored Indians, nor the iron men: in the English-speaking consciousness these men are neither cupric nor cuprous, ferric nor ferrous... No stannous-fighting man could ever take the place of our little tin soldier... This is my argument against any drastic action that would lead chemistry away from rather than into the humanities.

Bartow—While the elements first discovered have different names in different countries, these names are so few in number that adoption of uniform names would cause more confusion among the non-chemists than the divergent names cause to the chemists at the present time.

Bancroft—Since there is no reason to suppose that you can get universal approval of anything, it is a waste of time to select international names.

Patterson—Your article has in view a closer relation between chemists of all countries, which is fine. But it overlooks the relation between the scientist and the common people in each country. Such words as iron, gold, silver, belong to all English-speaking people, not to chemists alone. No matter what chemists do the people will continue to use these words, and if chemists substitute for them ferrum, aurum, and argentum (assuming they could do so successfully) they will simply widen the gap between scientific and every-day speech. Is this desirable? This is, to me, the chief objection.

Crane—It seems to me more important for the chemists and the people who are not scientifically trained in the various countries to use the same names than it does for the scientists of the various countries to do this. Much effort is expended nowadays to win popular appreciation of chemistry. It would work to the disadvantage of this movement to have the chemist break away from common usage as far as names of elements frequently met with are concerned.

An analysis of the votes shows that a larger number (37) were unreservedly opposed to a unification of the names of the elements than the number (29) who were in favor of it. If the names of the thirteen who suggested submitting the matter to an international commission and of the four who although in favor of the idea deemed it impractical, are counted as opposed, then the vote would be nearly two to one against the proposal.

Of the opinions against unification the most general and convincing appear to be (1) that tradition and the genius of languages must be respected, and (2) that divergences between scientific and every-day speech should not be increased.

It is evidently the opinion of a large number that progress of chemistry will be favored more by its widespread appreciation in each country than by facilitating inter-communication between the chemists of different countries. There appears to be a pronounced sentiment against developing closer international relations among chemists at the expense of familiarity with its terminology by the general public in each country.

The remaining four questions which were asked are subordinate to the first one, upon which such a decisive answer was obtained; hence, it is unnecessary to analyze the answers to them in detail. The opinions expressed may be briefly summarized as follows:

2. Only about one-third of those replying to this question thought that efforts to reform nomenclature would arouse chauvinistic or other antagonisms.

3. About one-half of all who replied suggested that the matter could best be handled by the International Union of Pure and Applied Chemistry.

4. Approximately two-thirds were in favor of the establishment of an international commission on the formulation of rules of nomenclature.

5. A large majority signified their willingness to participate in efforts to reform chemical nomenclature.

The results of this inquiry point out clearly that efforts to improve the nomenclature of chemistry must be confined to new names and to the harmonizing of variations in usage which do not conflict with fundamental language differences.

There is evidently little, if any, hope of gradually approaching a universal language by the progressive diminution of national variations in scientific terminology.

It may be concluded that the international language of the chemist will remain a combination of German, French, and English and those who aspire to proficiency in this science must continue to expend the effort necessary to learn these three languages.

In this connection it is especially noteworthy that the opposition to the unification of the names of the common elements was far greater among the chemists of Europe than among those of the United States and Canada. This may be due to the circumstance that European chemists, through generations of experience, are more proficient with languages, and hence do not realize the advantages which would result from the removal of this obstacle to more perfect intercourse between those engaged in the advancement of science.

This inquiry has demonstrated a simple method of collecting representative views upon questions of common concern, and has led to conclusions, the value of which cannot be doubted.

Finally, it should be mentioned that although the preponderating sentiment is evidently opposed to universal names for the fourteen common elements, it is probable that almost every one would be willing to have the names from which the symbols of the elements were derived, printed as synonyms in the tables of atomic weights published in each language. If this were done and all such tables arranged in the alphabetical order of the initials of the symbols, they would be uniform in all countries. This would undoubtedly lead to a standardization of the arrangement of material published in compendia and works of reference. Basic chemical literature would then gradually take on a more uniform character and would become of greater service to the chemists of all nations.

Plant Disease Fungus Mates Many Times. Polyandry still exists! Dr. Charles Drechsler, associate pathologist of the United States Department of Agriculture, has discovered a fungus associated with a root rot of corn which possesses 25 to 30 male elements for each female element involved in the reproductive processes. The disease which is produced by this extraordinary fungus is not serious.—*Science Service*

A CHEMICAL MUSEUM EXHIBIT

C. H. SPIERS, LEATHERSELLERS' COMPANY'S TECHNICAL COLLEGE, LONDON, ENGLAND

The easiest way to fill a museum is to assemble a collection of specimens in bottles, jars, dishes, etc., and to label them neatly. Such a collection is however "dead." It only comes to life when the visitor is conducted around the museum by a guide who knows the meaning of the specimens. This defect may be partially remedied by appending a written description to each exhibit, but there still remains the defect that the objects are isolated. The visitor will obtain a series of separate impressions which he must connect together for himself. The task of collecting together a set of impressions for a synthesis is irksome. One may start touring a museum with the firm intention of systematically examining every object but very soon one is darting about haphazardly looking at that which happens to catch the eye. Then the synthesis itself is difficult and without this synthesis much of the benefit of the museum visit is lost. The things seen on a given occasion must either fit together or fit into what has been previously seen or learned.

While, therefore, it is desirable for each specimen to speak for itself, it is perhaps even more desirable that specimens should be grouped together in sets to bring out special ideas and this as vividly as possible. Under these conditions the museum is "live." The exhibits are self-explanatory; the aid of a guide is not necessary. Further, this "unit construction" enables the visitor with little time to gain the maximum benefit. Naturally, this kind of arrangement requires much more thought and time than the more conventional one, if its object is to be achieved, and every display trick must be utilized.

Recently, an anonymous donor gave the Leathersellers' Company's Technical College a grant for the purchase of new museum fittings and the author was called upon to utilize some of the space for displays illustrating the chemistry and physics of leather manufacture, the scientific control of the tannery, the chemicals used in the tannery, etc. In designing a display, the author worked on the basis that a successful museum exhibit will have many of the features of a well-dressed shop window. The individual objects must be neat; the arrangement must be harmonious; the exhibit as a whole must attract attention; the eye must be irresistibly brought to the principal feature and then led away to the subsidiary ones; the important points must be clearly brought out.

One of the subjects chosen for display was the influence of water impurities on tannery processes. Water is one of the principal tannery chemicals. It is used in boilers for the generation of steam for heating and power. It is used for cleansing skins at various stages during the conversion to leather and it is employed as the reaction medium for various

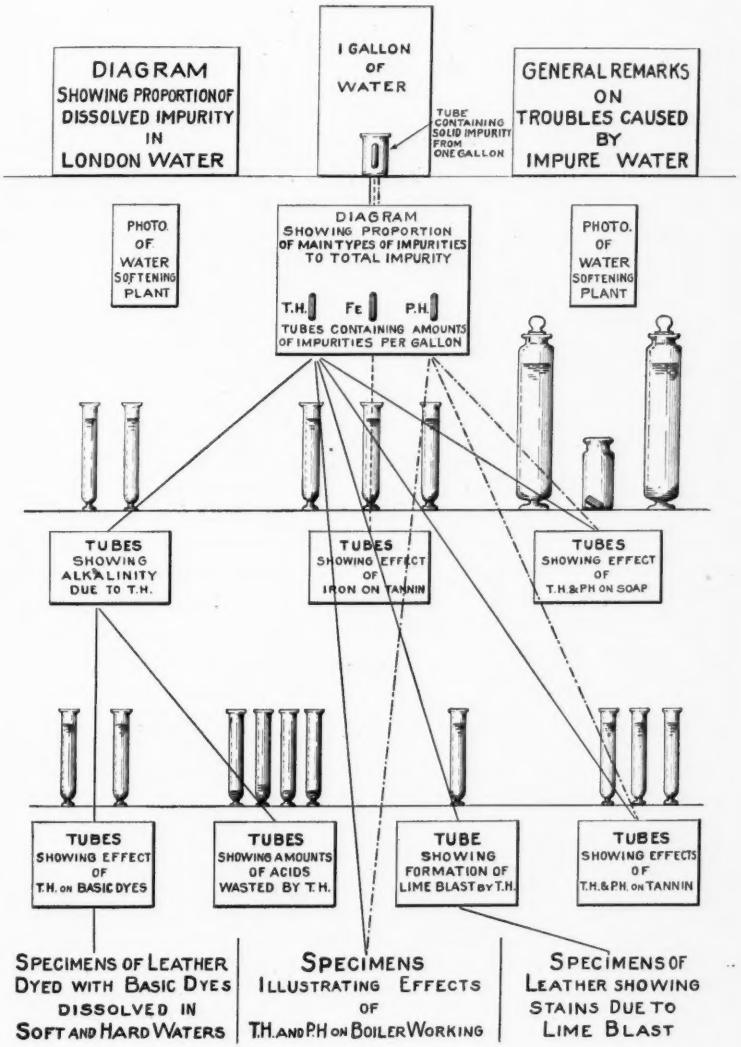


DIAGRAM
SHOWING PROPORTION OF DISSOLVED IMPURITY IN LONDON WATER
1 GALLON OF WATER
TUBE CONTAINING SOLID IMPURITY FROM ONE GALLON
GENERAL REMARKS ON TROUBLES CAUSED BY IMPURE WATER
PHOTO. OF WATER SOFTENING PLANT
DIAGRAM SHOWING PROPORTION OF MAIN TYPES OF IMPURITIES TO TOTAL IMPURITY
T.H. Fe P.H.
TUBES CONTAINING AMOUNTS OF IMPURITIES PER GALLON
PHOTO. OF WATER SOFTENING PLANT
TUBES SHOWING ALKALINITY DUE TO T.H.
TUBES SHOWING EFFECT OF IRON ON TANNIN
TUBES SHOWING EFFECT OF T.H. & P.H. ON SOAP
TUBES SHOWING EFFECT OF T.H. ON BASIC DYES
TUBES SHOWING AMOUNTS OF ACIDS WASTED BY T.H.
TUBE SHOWING FORMATION OF LIME BLAST BY T.H.
TUBES SHOWING EFFECTS OF T.H. & P.H. ON TANNIN
SPECIMENS OF LEATHER DYED WITH BASIC DYES DISSOLVED IN SOFT AND HARD WATERS
SPECIMENS ILLUSTRATING EFFECTS OF T.H. AND P.H. ON BOILER WORKING
SPECIMENS OF LEATHER SHOWING STAINS DUE TO LIME BLAST

chemical changes occurring in the tannery. In this last capacity, it is used as a solvent for soaps, dyes, acids, tannins, etc. The effects of water impurities on boiler working are well known. The impurities react with many of the tannery chemicals causing (1) wastage of chemical, and (2) production of inferior leather owing to stains, interference with finishing operations, etc.

The important features in connection with tannery water have been brought out in the manner depicted in the diagram. The case available has glass walls and measures 66″ × 36″ × 20″. It has three staggered glass shelves. At the top are exhibits showing the amounts of impurities per gallon of London water. On the two lower shelves are exhibits showing the reactions of these impurities with tannery chemicals. On the floor of the case are technical specimens demonstrating the effects of the impurities in working practice. The rectangles represent cards bearing concise descriptions of the various items. The lines connecting the cards represent ribbons of different colors. The eye naturally starts at the central card and travels along the ribbons to the various specimens. The effects of temporary hardness, permanent hardness or iron are easily picked out by blue, red, or green ribbons. The case vividly teaches the brief facts relating to a definite problem.

All the tricks of the window dresser are used and indeed his various little gadgets—clips, struts, stands, etc.—have been found most useful in setting up the exhibit. Were a larger case available, one might add objects illustrating water testing and softening.

Lack of Training Chief Cause of Failure. Lack of proper training during childhood, and not lack of ability, was blamed for most of the failures in life by Dr. Sanger Brown, speaking at the recent session of the Orthopsychiatric Association in New York. Dr. Brown discussed the chief reasons why people fail and become dependent.

Actual lack of ability does cause some failures, Dr. Brown said, but the number of such failures is far less than might be supposed. A neglected child who receives little training and has little sense of responsibility is apt to become shiftless and improvident in later years. Some people can overcome handicaps of this sort, but many cannot.

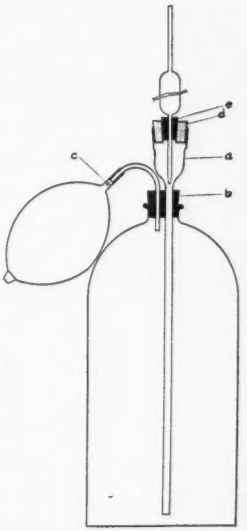
Certain unfortunate mental traits and characteristics that are acquired during childhood are also potent causes of failure later in life, Dr. Brown stated. Such traits injure the personality and are thus a big handicap throughout life. In this class belong the querulous, the brow-beaten, the ambitionless, the fault-finder. They do not lack intelligence and their mental defects are generally acquired during childhood and not inherited.

Proper education will prevent failures in two ways. It will prevent the development of such handicapping mental traits and attitudes and will give the child training in a profession or trade to which he is naturally adapted.—*Science Service*

APPARATUS FOR FILLING PIPETS AND BURETS WITH CORROSIVE SUBSTANCES[1]

ROBERT F. MCCRACKAN, MEDICAL COLLEGE OF VIRGINIA, RICHMOND, VIRGINIA

The figure here shown is almost self-explanatory. To fill a pipet or a buret with a liquid, the tip of the pipet or buret is passed through a rubber stopper, *e*, number 00, which fits into a hollow glass stopper, *d*, ground to fit the mouth of a funnel tube, *a*, that passes through a two-holed rubber stopper, *b*, in the bottle containing the liquid. The pipet is held in place by means of the right thumb and middle finger, and the liquid is forced up by pressure on the rubber bulb from the left hand while the left thumb and index finger are held over the holes at *c*. When the right index finger is placed on the pipet, and the left hand removed, atmospheric pressure is restored automatically. The ground glass stopper is loosened and held firmly attached to the rubber stopper on the pipet by means of the left hand, while the liquid is drawn down to the mark, and the drop touched off, and the pipetting completed.



The apparatus is similar to that shown in Figure 3 of a previous paper,[2] which can be made to serve every purpose if extreme care is taken to keep drops of the liquid being pipetted from getting into the mouth of the tube where the rubber stopper fits. Experience has shown that untrained students pipetting concentrated sulfuric acid or 40% sodium hydroxide in the determination of nitrogen soon get them on the rubber stopper. The introduction of the glass stopper around the rubber stopper prevents this.

In measuring approximately such things as the sulfuric acid for a Babcock fat determination or for a Kjeldahl nitrogen determination, or 40% sodium hydroxide, very quick delivery from the pipet can be obtained by giving it a wide mouth. To measure accurately such substances as concentrated hydrochloric, nitric, and acetic acids, concentrated ammonium hydroxide, acetone, and ether, all of which attack the mucous membrane of the mouth when a pipet is filled by suction, a pipet much constricted at the tip should be used, and the receiver for the substance pipetted should be held very close to the funnel tube.

[1] Read before the Division of Biological Chemistry at the 76th Meeting of the A. C. S., September 11, 1928, at Swampscott, Mass.

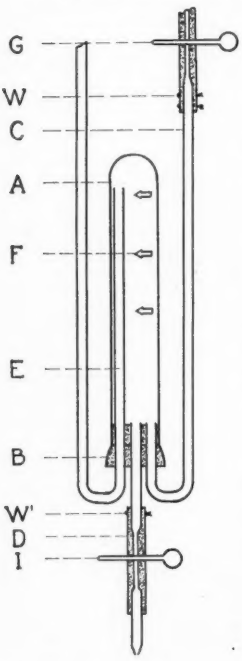
[2] Robert F. McCrackan and Emanuel Passamaneck, "Sanitation, Safety, and Convenience in Pipetting," THIS JOURNAL, 5, 343–8 (Mar., 1928).

A DISPENSING BURET FOR STRONG ALKALI

E. F. ALMY, OHIO STATE UNIVERSITY, COLUMBUS, OHIO

For the measurement of 50% NaOH for Kjeldahl nitrogen determinations, and in other cases where strongly alkaline solutions are to be measured with a limited degree of accuracy, the apparatus pictured in the accompanying figure will be found useful. It can be made from materials to be found around almost any laboratory, and requires only a limited amount of glass-working.

The main features of the device are readily seen from the sketch. *A* is a lipless test tube $1^1/_4'' \times 8''$, and it is closed by the three-hole stopper *B*. One opening of this stopper carries the inlet tube *C*, coming from the supply bottle which must be at a level above the upper end of the tube *A*. The flow of the liquid from the supply bottle is controlled by a pinch-cock *G*, placed at any convenient point in the supply line. The second opening in *B* carries the delivery tube *D*, made up of a glass section, a section of rubber tubing, and a glass nozzle, the outflow being controlled by a second pinch-cock *I*. The third opening carries the safety tube *E*, leading from a point above the highest desired level in tube *A* to above the level of liquid in the supply bottle. In case of leakage through *G*, or of leaving *G* open accidentally, the liquid then simply fills the tube *A*, overflows into the safety tube *E*, rises to the level in the supply bottle and stops. In this way accidental loss of the stock supply is prevented.



Determination of the volume delivered may be accomplished by the "cut and try" method, delivering portions into a graduated cylinder until the proper level for the desired volume is found. If more accuracy is desired, the inlet tube may be filled with water and closed by pinch-cock *G*, any water in the tube *A* then being drained out. A pipet of the desired capacity is filled to the mark, its tip inserted in the inlet tubing and allowed to drain after opening pinch-cock *G*. The height to which the liquid rises may then be marked by gummed labels, etc., as at *F*. Copper wire binding of the rubber glass junctions at *W* and *W'* is essential to prevent the creeping out of the alkali at these points.

To use the device after it is assembled it is supported at any convenient height by a condenser clamp and ringstand, and connected to the supply bottle by a sufficient length of rubber tubing attached to the inlet tube *C*.

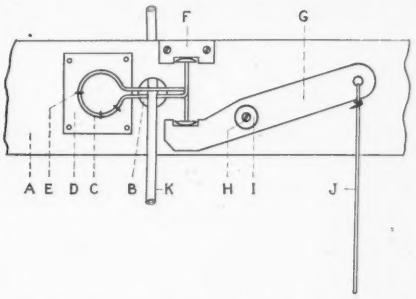
Only the lower portions of the supply line and safety tube are shown in the sketch. For the 50% NaOH and similar viscous solutions care should be taken not to use less than $^1/_4''$ tubing, or the rate of flow will be slow.

A SAFEGUARD FOR STOCK SOLUTIONS

E. F. ALMY, OHIO STATE UNIVERSITY, COLUMBUS, OHIO

In using standard solutions drawn by siphoning from stock bottles into burets equipped with two-way stopcocks loss of solution has occurred several times due to rupture of rubber tubing used to connect the lower end of the supply line to the buret. If this happens when no one is in the laboratory the entire stock of solution is lost. The device sketched in the accompanying figure has solved the problem, and no further losses have been experienced since it was installed.

A piece of $1'' \times 3''$ strip A serves as the frame-work for the device. A $\frac{3}{4}''$ hole B is bored in this and a pinch-cock C is mounted in front of the hole. The pinch-cock is supported somewhat away from the frame by mounting it on the $\frac{1}{2}''$ block D, and is held in place on this block by staples as at E, and by the block of wood F. The pinch-cock is operated by the lever G, held to the frame by a screw H and with washers I on each side of the lever. The lever may be operated from below by pulling or releasing the string J, which extends down to the level of the buret.



In use this frame A is mounted at a level just above the highest solution level desired in the stock bottle, by fastening it to the shelf with upright strips at each end. A section of rubber tubing K is put in the supply line passing from the glass siphon coming from the stock bottle through hole B from the back of the frame to the front and is there connected to glass tubing leading down to the two-way stopcock of the buret.

To operate the device after the siphon is started, simply turn the two-way stopcock to allow liquid to enter, and pull gently on the cord. By controlling the tension used the liquid flow can be held at any rate desired. If preferred, the pinch-cock can be held open by pulling the cord down, and the two-way stopcock used to control the rate of filling.

In case of a break below the guard only the liquid below it is lost. If the break is above the guard the liquid in the siphon simply flows back into the bottle.

PROGRAM OF THE DIVISION OF CHEMICAL EDUCATION

COLUMBUS MEETING OF THE AMERICAN CHEMICAL SOCIETY, APRIL 29–MAY 2, 1929

This notice was necessarily incomplete at the time it was submitted to the Editor of the JOURNAL. The final program will appear in the April 20th *News Edition* of *Industrial and Engineering Chemistry*.

Monday, April 29

8.00 A.M. Breakfast meeting, Executive Committee, Division Chemical Education. Neil House.

8.00 P.M. Reception. Neil House.

Tuesday, April 30

8.00 A.M. Breakfast meeting, Committee of Chemical Education. Neil House.

9.30 A.M. General Meetings. Chemical Laboratory.

2.00 P.M. Division Chemical Education (Chemical Laboratory).

V. F. PAYNE. "Lecture Demonstration or Individual Laboratory Work for Beginners?"

W. E. BRADT AND E. H. SMOKER. "More Effective Individual Laboratory Instruction in General Inorganic Chemistry."

W. D. COLLINS. "A Laboratory Exercise on Reagents."

FREDERICK SMITH, V. L. HARDY, AND E. L. GARD. "The Segregation of Analytical Samples."

M. G. MELLON. "A Book Support for the Chemical Laboratory."

MAUDE B. SCOFIELD. "Further Studies on Sectioning Students in General Chemistry."

J. E. DAY. "Memorials in Chemistry Laboratories."

5.00 P.M. Meeting of Editors of JOURNAL OF CHEMICAL EDUCATION.

8.00 P.M. Entertainment (Neil House).

Wednesday, May 1

8.00 A.M. Breakfast Meeting of the Senate of Chemical Education.

10.00 A.M. Division Chemical Education (Chemical Laboratory).

A. L. FERGUSON. "Our Changing Education."

PAUL H. FALL. "The Teaching of Qualitative Analysis in the General Chemistry Course."

W. C. FERNELIUS AND I. SCHURMAN. "Demonstration of Manipulation of Liquefied Gas."

12.00 M. Luncheon (H. S. Teachers)

2.00 P.M. **Symposium on Lecture Experimentation.** (Chemical Laboratory.)

N. W. RAKESTRAW. "The Function and Limitation of Lecture Experiments."

JESSE E. DAY. "Lecture-Table Design and Permanent Equipment."

S. R. BRINKLEY. "Oxidation-Reduction."

RUFUS D. REED. "Essential Lecture Demonstrations in Secondary Chemistry."

6.00 P.M. Group Dinners.

8.00 P.M. (Memorial Hall) Public lecture by C. E. K. Mees, "The Formation of the Photographic Image."

Thursday, May 2

9.00 A.M. **Symposium** (cont.). (Chemical Laboratory.)
C. E. BOORD. "Lecture Demonstrations in Organic Chemistry."
I. M. KOLTHOFF. "Lecture Demonstrations in Analytical Chemistry."
W. H. CHAPIN. "Lecture Experiments in Second-Year Chemistry."
C. S. ADAMS. "Hydrogen."
11.00 A.M. Business Meeting of the Division of Chemical Education.
12.00 M. Luncheon at the Battelle Institute.
2.00 P.M. Trip to Ohio Wesleyan Campus.

R. A. BAKER,
Secretary, Division of Chemical Education

ASSISTANT CHIEF OF PROTECTIVE DIVISION (PRINCIPAL CHEMIST), AND FIVE SENIOR CHEMISTS (HEADS OF DIVISIONS), TO BE APPOINTED IN CHEMICAL WARFARE SERVICE

The United States Civil-Service Commission states that the positions of assistant chief of protective division (principal chemist) and five senior chemists (heads of divisions), Chemical Warfare Service, Edgewood Arsenal, Maryland, are vacant, and that in view of the importance of these positions in the field of chemical research the method of competition will be as follows:

Instead of the usual form of civil-service examination, the qualifications of candidates will be passed upon by a special board of examiners composed of Dr. A. C. Fieldner, Chief Engineer, Experiment Stations, Bureau of Mines; Dr. J. E. Mills, Chief Chemist and Assistant to the Technical Director, Edgewood Arsenal; and Dr. A. S. Ernest, Examiner of the U. S. Civil-Service Commission, who will act as chairman of the committee. For the purposes of this examination, all of these men will be examiners of the Civil-Service Commission.

The entrance salaries range from $5600 to $6400 a year for assistant chief of protective division (principal chemist) and from $4600 to $5200 a year for senior chemists (heads of divisions).

Formal applications will be received by the Civil-Service Commission until May 8th. Full information may be obtained by communicating with the United States Civil-Service Commission, Washington, D. C.

Pearls 25,000,000 Years Old Found in California Rocks. Ten pearl-like fossils found by geologists of the University of California in rocks laid down about 25,000,000 years ago have proved under test to be real pearls, conforming in structure with the modern variety, and having as their source molluscs related to the present pearl oyster.

The pearls were uncovered while the university men were searching for fossils of the Cretaceous period near Redding, Calif. In spite of their 25,000,000-year burial, from the time when dinosaurs were making their last stand on earth, the pearls still maintain a little of their luster.

Such finds are extremely rare. Some years ago one was reported in England, from the same mollusc and the same period in the earth's history, and one other from the same period has been reported from Texas. In size the California pearls vary from three-sixteenths to five-sixteenths of an inch in diameter.—*Science Service*

The Chemistry Student

IMPORTANT POINTS IN THE DEVELOPMENT OF THE MANUFACTURED GAS INDUSTRY WITH PARTICULAR REGARD TO THE INFLUENCE OF CHEMICAL RESEARCH

JOHN H. WOLFE, CONSOLIDATED GAS ELECTRIC LIGHT AND POWER COMPANY OF BALTIMORE, MARYLAND

The futile endeavors by the ancient philosophers, known as alchemists, to change or transmute the baser metals into gold led to the discovery of manufactured gas.

During the seventeenth century Jean Baptist Van Helmont of Brussels, while working on transmutation, broadened his original line of experimentation and made some of the earliest and most important contributions to modern chemistry. About 1609, while experimenting with fuels, he discovered that they yield what he described as a "wild spirit." Although Van Helmont recognized the existence of various gases he was unable to perfect a way of confining them. It remained for others to perfect methods for storing gas and thus open the field to its ultimate and maximum usefulness.

WILLIAM MURDOCK
Lighted his home in England with gas in 1792.

A few years after Van Helmont made his discoveries and while other chemists were endeavoring to become acquainted with the hidden laws of Nature, natural gas was found in various places in England. The earliest description of these discoveries is in a communication by Thomas Shirley to the Royal Philosophical Society in 1667.

Dr. John Clayton, a Yorkshire minister, with an inclination for the sciences, conducted experiments about the year 1665 with gas which he had produced from coal.

It remained for William Murdock, a construction and erection engineer,

and for James Watt, who developed the steam engine, to produce gas from coal on a scale that would make possible its use for lighting. In 1792 he lighted his home with gas distilled from coal in an iron retort. In 1798 he installed an apparatus for lighting the factory of Boulton Watt and Company. Murdock next built a gas works and lighted the cotton mill of Phillips and Lee at Manchester with gas burners in 1804. He read a paper describing this installation before the Royal Society of London in 1808, and was awarded the Rumford Gold Medal. Murdock's achievements were along such practical lines that he is recognized as the father of the gas industry.

In 1781 Lavoisier invented the gas holder.

PHILIPPE LEBON
In France some claim that Lebon was assassinated by order of the British government because of his claim to be the inventor of gas lighting.

DR. CARL AUER VON WELSBACH
Inventor of the incandescent gas mantle.

Jean Pierre Minckelers, after many experiments, in 1784 lighted gas distilled from coal as a demonstration to his class in the University of Louvain.

In 1799 Philippe Lebon obtained a patent in France for making gas by distilling coal or wood.

These various demonstrations came to the attention of Frederick Albert Winsor, a German, who, although apparently more of a promoter than a scientific research worker, played a prominent part in establishing the first gas company in the world, and accelerated the general use of gas for domestic purposes. The English Parliament

FREDERICK ALBERT WINSOR
Organized the first gas company in the world—chartered in London in 1812.

granted a charter to his company, "The London and Westminster Gas Light and Coke Company," in 1812.

Following the success of gas lighting in London it spread quickly to other countries. In 1816 the first gas company to be founded in the United States was established in Baltimore as "The Gas Light Company of Baltimore." Paris was lighted with gas in 1820.

Many important contributions to the gas industry were made by the early workers. Samuel Clegg, Engineer of the first London company, introduced the wet lime purifier in 1809; the hydraulic main in 1812; the wet meter with revolving drum in 1816; and the dry meter in 1830. The discovery of benzol was made by Faraday in 1825. In 1855 Robert Wilhelm von Bunsen devised a burner which is the basis for gas utilization. In 1856 William Henry Perkin discovered the first coal-tar dye—mauve. In 1885 the incandescent gas mantle was invented by Welsbach.

Professor Thaddeus S. C. Lowe in 1873–74 invented the carburetted water gas process which is known by his name. Professor Lowe's first introduction to gas making was as a balloonist in 1862, during the Civil War. He generated gas on the battlefield at Yorktown,

PROFESSOR THADDEUS S. C. LOWE
Inventor of the Lowe water-gas process.

and at Fair Oaks, Virginia. The Union forces were greatly aided by the observations which he made from his balloon.

Tessie du Motay, a Frenchman, was also engaged in perfecting a form of water gas in America at about the same time that Lowe introduced his process.

During recent years the gas industry has made great progress as a result

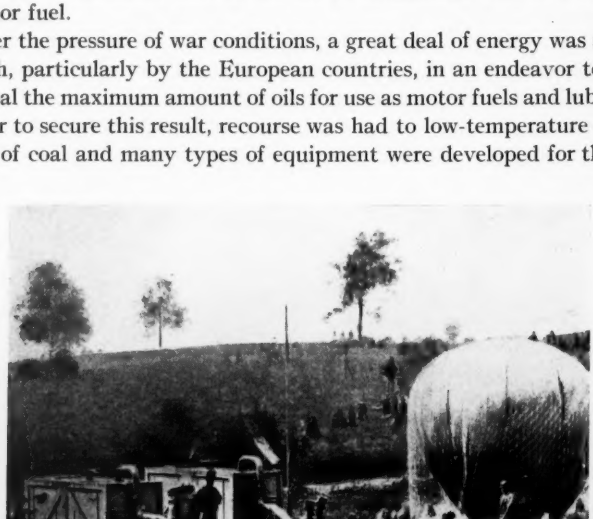
PEALE'S MUSEUM, BALTIMORE, IN 1916
Gas lighting was exhibited here on June 13, 1816.

of the scientific research work undertaken by its engineers and chemists. Old processes have been modified and improved, and new processes have been developed.

In the field of gas manufacture a vast amount of work has been done on the constitution and physical and chemical properties of coal and coke. This work has been of great value to the coal gas industry. The water gas

industry has profited by such modifications as the back run, Chrisman cycle, and the use of automatic charging and clinkering machines. This branch of the industry has also made rapid progress in what is practically complete carbonization, that is, the use of bituminous coal as a water gas generator fuel.

Under the pressure of war conditions, a great deal of energy was spent in research, particularly by the European countries, in an endeavor to secure from coal the maximum amount of oils for use as motor fuels and lubricants. In order to secure this result, recourse was had to low-temperature carbonization of coal and many types of equipment were developed for that pur-



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FILLING PROFESSOR LOWE'S BALLOON ON THE BATTLEFIELD

pose. By using such methods the maximum yield of liquid products is obtained. Considerable research work on this problem is still being carried on in Europe and America. The economic desirability of utilizing such methods, however, depends entirely upon the value which can be placed upon the by-products, *viz.*, the light tars and oils produced under this method of carbonization. In the event that we are called upon to face a reduction in the supply of crude oil and petroleum products, many of these systems of carbonization may be adopted as being commercially desirable.

In the field of gas utilization new research work is rapidly expanding. The American Gas Association has established a testing laboratory which is

SPRING GARDENS GAS WORKS OF THE CONSOLIDATED GAS ELECTRIC LIGHT AND POWER COMPANY OF BALTIMORE
All of the gas used in Baltimore is distributed from this plant which covers 57 acres. It is one of the largest and most modern gas plants in America.

constantly adding to the knowledge of the proper utilization of gas in domestic as well as industrial appliances. Many universities are also working on this most important problem.

The Consolidated Gas Electric Light and Power Company of Baltimore recently established a Research Department, and has men engaged at the present time on different problems of research in the fields of production, purification, and by-product recovery, as well as utilization.

Among the important problems which are of interest to the gas industry are the following:

1. The synthesis of motor fuels and alcohols from water gas.
2. The catalytic enrichment of blue gas.
3. Studies for the improvement of present methods, or the development of new methods for removing hydrogen sulfide from gas with subsequent recovery of the sulfur as a by-product.
4. The removal of organic sulfur compounds from the gas.
5. The removal of the constituents of gas which accelerate corrosion, such as cyanogen, oxygen, and water vapor.
6. Processing of coke oven gas to recover a greater percentage of valuable constituents.
7. Treatment of bituminous coal to recover the volatile matter as gas prior to burning the residue under boilers.

In addition to the above, there are many other production and utilization problems that are continually demanding the attention of the gas men. The entire manufactured gas industry realizes the importance of research to effect economies in production and increase the utilization of its product, To this end the national association, as well as the individual companies, is placing an increasing load on the research departments.

Future World's Metal Supply Doubtful. The world's metal supplies in the rocks of the earth are showing signs of failing and experts are worried over whether the most efficient applications of science and technology can keep pace with the demands of coming generations, according to D. F. Hewett, geologist of the U. S. Geological Survey.

The European trend toward cartels and understandings to control such metals as iron and steel, mercury, aluminum, zinc, lead, and copper has arisen from the unspoken realization that Europe's metal production has taken a downward tendency.

In America vast resources of iron, copper, lead, zinc, silver, and gold have been attacked so vigorously that many leading districts are approaching exhaustion, and metal production is being maintained by the application of new metallurgical processes to lower grade ores. American mining operations are deepening shafts at a rate two to four times as fast as those of Europe, Mr. Hewett observed.

If we are willing to pay the price in fuel, power, and labor, enough iron, manganese, aluminum, and gold can be produced, Mr. Hewett indicated; but mercury, lead, and chromium are less likely to be produced in sufficient quantities for future generations even if the price is increased to stimulate the supply.—*Science Service*

A WORKING MODEL BY-PRODUCT COKE PLANT. A CHEMISTRY PROJECT FOR A STUDENT AT THE SECONDARY LEVEL*

HOWARD WILLIAMS, WESTERN RESERVE ACADEMY, HUDSON, OHIO

One day a boy came to me and said, "I am interested in the by-product coke plant. Would it be possible for me to build one in the laboratory that would have all the parts and do all the things that the commercial plant does?"

I reminded him that we had performed the usual laboratory exercise on the destructive distillation of coal, but he was not satisfied with that. He said that the apparatus we had used—a couple of test tubes and a beaker—was only a toy. What he wanted was to build a real, working-model coke plant.

The result of the conference was that he went to the library with some suggestions and a great deal of enthusiasm. He took notes on everything that he could find about the destructive distillation of coal. He then brought his notes in for a second conference, and we mapped out a working plan.

First, he wrote a letter to the manager of the coke plant of the American Steel and Wire Co., Cleveland, Ohio. This plant is about twenty-five miles from our school. The letter was a request for permission to visit the coke plant. The permission was graciously granted, and the boy made a trip through the plant. He saw the process from start to finish. He had a conference with the head chemist. He was shown the blue prints of a small experimental coke plant, similar in many ways to the one he wished to build, which was then being built by the company for use in research. He came back full of ideas and burning to get to work.

Next, working together, we made a diagram of the plant that he wished to build. I gave him a table about two feet wide and six feet long upon which to build the plant, and he started to work. Many problems arose before the task was finished, but together we ironed them out. Finally, after about four weeks of the most interesting work that I have ever seen done at the secondary level, he had a very complete little coke plant that worked.

He built two ovens or retorts so as to be able to run the plant continuously. These were made of two pieces of ordinary 2″ black steam pipe, 9″ long. One end was threaded and fitted with a 2″ cap. The other end was closed by having a piece of flattened pipe welded onto the retort. The welding was done by a local garage man at a cost of fifty cents. Two inches

* The apparatus herein described was on display at the conference of the Progressive Education Association, Hotel Jefferson, St. Louis, Mo., February 21, 22, 23, 1929.

from the closed end of this retort, a hole was drilled with a standard $\frac{5}{16}''$ drill and tapped to receive a $\frac{1}{8}''$ pipe nipple. This was the outlet for the gases. The retorts and their connections were then assembled with $\frac{1}{8}''$ pipe fittings as shown in Figure 1. A $\frac{1}{8}''$ globe valve with two female threads was used in the gas line from each of the retorts so that one could be shut off for cleaning and recharging while the other one was being heated.

A heat-insulating jacket was placed around the retorts so as to prevent the loss of heat and make it possible to attain within the retorts a tempera-

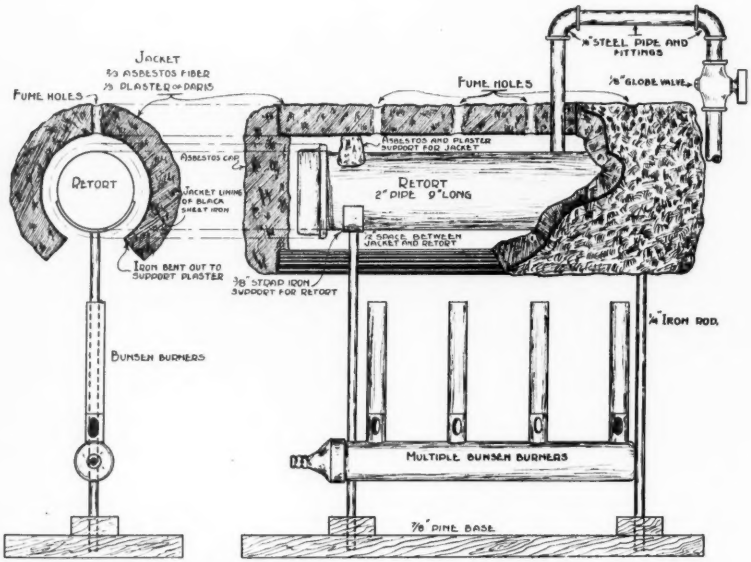


FIGURE 1.—COKE RETORT, SHOWING DETAILS OF PIPE-FITTING

ture high enough to coke the coal. These jackets were composed of a mixture of two parts asbestos fiber and one part plaster of Paris. Each jacket was supported on a sheet iron lining which was placed around the retort so as to leave about $\frac{1}{2}''$ between the jacket and the retort. A long slot was left in the under side of the jacket for the entrance of the flames from the burners used to heat the retorts. Four round holes about $\frac{1}{2}''$ in diameter were also left in the top of each jacket for the escape of burned gas fumes, and also to allow the flames to circulate completely around the retorts. Figure 1 also shows a cross-section of the retort and jacket, and will give a clear idea of the assembly.

At a distance of about 6″ from the tee where the gas lines from the two retorts joined, the steel piping was discontinued and glass tubing was used from there on. This made it possible to observe any action that took place in the rest of the apparatus.

Figure 2 shows the assembly of the entire plant. The gas line from the retorts was run into three coolers to condense the tar from the hot gases. These were made from three large test tubes immersed in a pneumatic trough through which a circulation of cold water was maintained. The tarry material gathered in the tubes, and the gases passed on and out through the tube, "T." The tar was brown in color when first condensed, but upon standing for a few days it became black and separated from the ammoniacal liquor with which it had been emulsified.

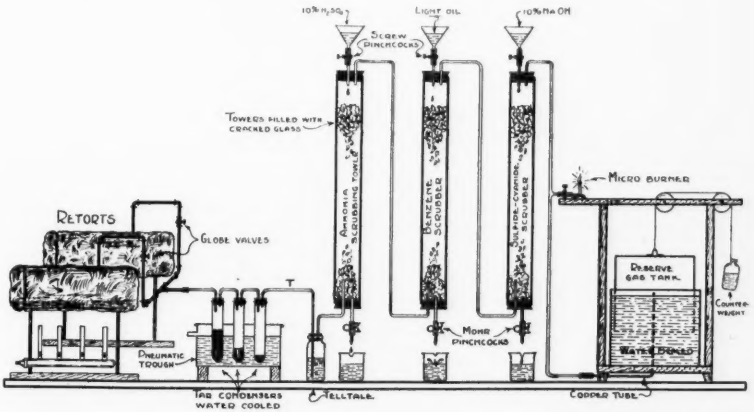
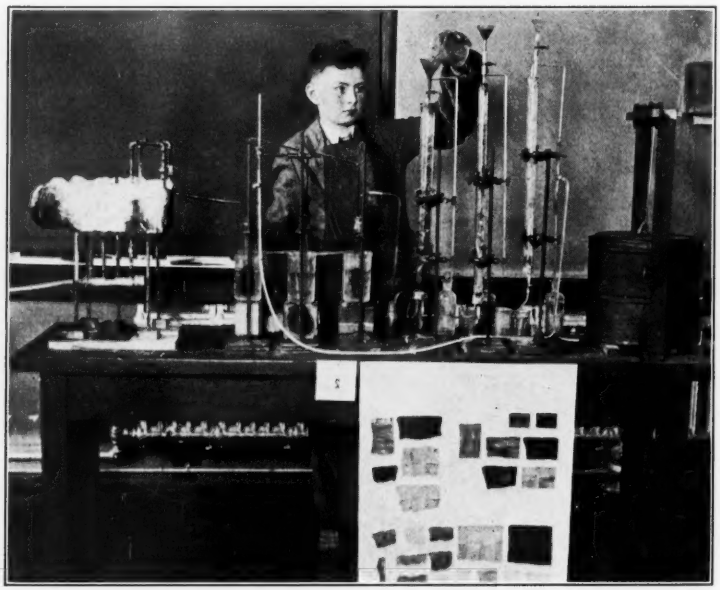


FIGURE 2.—ENTIRE ASSEMBLY OF THE COKE PLANT

Following the coolers was a small bubbler bottle which was used as a tell-tale. So long as gas was being given off from the retorts the bubbling in the bottle would indicate its passage. When the bubbling slowed down the second retort was started and by the time the bubbling had entirely ceased—showing the first retort to be out-gassed—the second one was ready to deliver gas. The first retort was then shut off, allowed to cool, the coke removed, and the retort recharged for the next heating. The tell-tale was about half full of a 10% solution of sulfuric acid, which helped to remove ammonia gas as well as acting as an indicator of gas flow.

From the tell-tale the gas was led into the bottom of the first scrubbing tower. Each of these towers was made of an 18″ section of the 1½″ glass tubing usually used in the physics laboratory for depth-pressure measure-

ments. Each tower was filled with broken glass in pieces about $\frac{1}{4}''$ in diameter. This was to give plenty of surface for contact of the gas with the scrubbing liquid introduced at the top of the tower. Both ends of the towers were fitted with two-holed rubber stoppers. The gas entered through one of the holes in the bottom stopper, and the used scrubbing liquid was removed through the other by means of a short piece of glass tubing to which was fixed a short piece of rubber tubing and a pinch-cock. The scrubbing fluid was introduced through one of the holes in the upper stopper through a glass dropper tip. A glass funnel was coupled to this



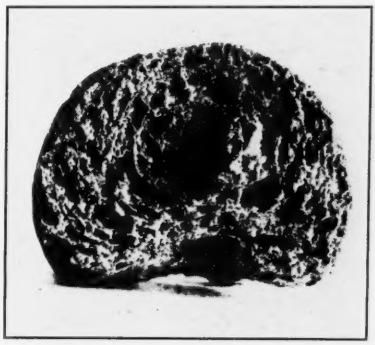
THE MODEL COKE PLANT AND THE BOY WHO BUILT IT

tip by means of a short piece of rubber tubing. A screw pinch-cock was placed on the rubber tubing to regulate the speed of dropping of the scrubbing liquid. The second hole in the upper stopper was used for the outlet gas tube to the next tower.

From the third or last scrubbing tower, the gas was led to the reserve gas tank, and also by means of a glass tee tube to a small micro burner where the gas could be used.

The reserve gas tank was a container for unused gas, and also a means of keeping a constant supply and pressure of gas for the micro burner which

represented the consumer. It was made of two large tin cans. The inner can was the bottom half of a five-gallon denatured alcohol can. The outer can was of the same depth as the inner one, but had a diameter about two inches greater. This allowed free motion between the two cans. The outer can was about ten inches deep. A piece of copper tubing about 20″ long was soldered through the center of the bottom of the outer can so that the end inside the can was about $\frac{1}{2}$″ below the level of the top of the can. The copper tube below the bottom of the can was then bent at right angles over a round form and attached to the gas line from the last scrubbing tower. Both cans were painted with heavy black roofing paint to prevent rusting. The lower can was filled with water to within $1\frac{1}{2}$″ of the top, and the upper can inverted into it. The upper can was counterweighted by means of a piece of string, a couple of pulleys, and a weight, so that it exerted a pressure of about two ounces to force the gas out of the tank. It was found that a very convenient counterweight was made of a glass bottle with some water in it. By adding or removing a little water from the bottle the counterweight could be quickly and easily adjusted.



A SECTION OF UNBROKEN COKE FROM THE RETORT

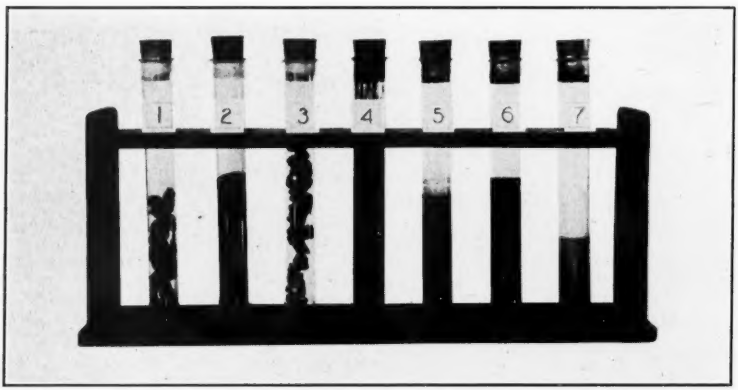
Note the concentric circular structure of the pores showing the progress of the coking from the outside toward the center of the charge. If the center of this structure is displaced to one side of the center of the charge it means that the heating is not uniform from all sides.

The coal for the retort was ground in an iron mortar so that it would pass through a twenty-mesh sieve. It was afterward sifted in a sixty-mesh sieve to remove fine coal dust which would cake and cause trouble in the retorts. The retorts were then charged with the clean ground coal. They were filled about half full so as to allow for expansion when the charge was heated, and for slight frothing when the gas was coming off rapidly. Before placing the cap on the retort, the threads on both the cap and the retort were generously painted with a mixture of heavy lubricating oil and graphite. This served the double purpose of helping to make the retort gas tight, and also of preventing sticking when the cap had to be removed to take out the coke of the spent charge. The firing was started slowly and gradually increased to a maximum just as the coal was about out-gassed.

The scrubbing liquid used in the first tower was a 10% solution of sulfuric acid. This removed uncombined ammonia. The combined ammonia was

found in the ammoniacal liquor which collected on the top of the tar in the tar coolers. The scrubbing liquid used in the second tower was a very light lubricating oil. This removed the benzene vapors from the gas, they being soluble in light oils. The liquid used in the third tower was a 10% solution of sodium hydroxide. This caught the hydrogen cyanide and hydrogen sulfide in the gas, and removed them as sodium cyanide and sodium sulfide, respectively.

The ammoniacal liquor upon treatment with a little sodium hydroxide gave off strong fumes of ammonia, thus showing the presence of combined ammonia in the liquor. The sulfuric acid from the first tower and from the tell-tale gave a small mass of crystals of ammonium sulfate upon evapora-



SOME SAMPLES OF THE RAW MATERIALS AND THE PRODUCTS OF THE MODEL COKE PLANT

1. The coal before grinding. 2. The coal after being ground. 3. The coke from the retorts. 4. Some of the coal tar. 5. The washings from the ammonia tower. These scrubbing liquids were run through the towers several times so as to nearly saturate them. 6. The oil from the benzene scrubber. 7. The washings from the cyanide-sulfide tower.

tion. These crystals were grayish in color due to impurities. The addition of sodium hydroxide to these crystals gave unmistakable evidence of their ammonia content.

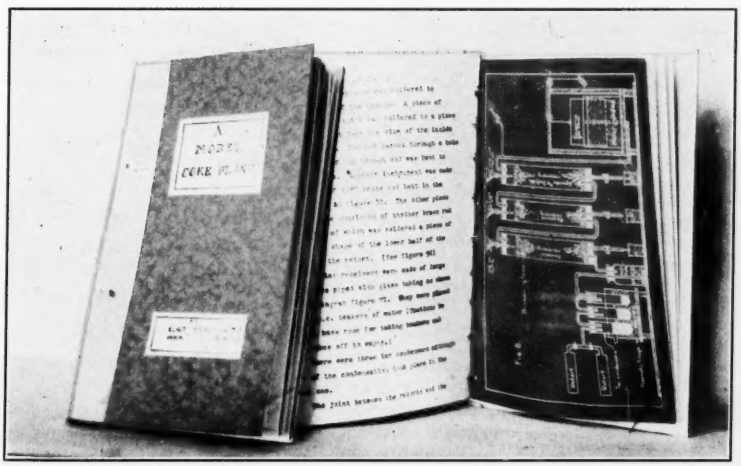
The light oil from the second tower yielded two or three cubic centimeters of benzene oils upon very careful distillation with a small condenser.

The sodium hydroxide from the third tower was treated with ferrous sulfate solution. A heavy black precipitate of iron sulfide gave evidence of the presence of sulfides in the gas. This sulfide precipitate was filtered off, and the filtrate boiled with a little more ferrous sulfate. If cyanides were present, this treatment would yield sodium ferrocyanide. A few drops of

ferric chloride were then added. A faint blue color due to the presence of Prussian blue proved the presence of traces of cyanides in the coal gas.

The plant had worked. Everything the boy had started out to do was accomplished. He was overjoyed, and so was I. It was a real bit of secondary-school research, planned and carried out by a boy of high-school age. It had proved beyond doubt that such projects in high-school chemistry are not only possible but intensely interesting and profitable adjuncts to the usual high-school course.

The boy had not received all the benefit from the project. His work and the plant attracted the attention and interest of other members of the class, and I immediately began to get requests from others to be allowed to do



THE BOUND COPY OF THE REPORT

some similar piece of work along the lines of their special interests. The result was that several other remarkable bits of work were done. The interest also spread to the rest of the school and resulted in a rather widespread and general interest in the chemistry course.

The final step in bringing this project to a well-rounded conclusion was the preparation of a carefully written report of the work. This report was typewritten on $5\frac{1}{2}'' \times 8\frac{1}{2}''$ paper (half letter head size), and hand-bound in attractive board covers. The booklet also included blueprint drawings of the apparatus used, and a photograph of the boy and his apparatus. The drawings for the blueprints were made by the boy himself, the photograph was made by a classmate who was interested in photography, and the booklet was bound and decorated by the boys in the art department of

the school. The booklet was typed and bound in triplicate. One copy became the property of the boy. A second copy was given to the school and placed on the reference shelves of the school library for the benefit of any one who might wish to repeat the work another year. The third copy went to the instructor who, I can assure you, was delighted to have this memento of the project in his personal files.

The idea of substituting this type of project and report for the usual obnoxious—to both student and instructor—semester paper was a very happy outgrowth of this piece of work. I have now completely discarded the old type of semester paper drudgery in favor of this new, live-interest method of getting a student to go somewhat beyond the textbook and regular course of study in the field of chemistry. It does all and more than was ever accomplished by the semester paper by bringing real interest and enthusiasiasm into the work. The drudgery of reading the usual uninteresting, technical material, the painful note-taking, and the distressing composition of dead material is all supplanted by intriguing work leading to a goal desired by the pupil, and followed by living composition of actual interest material gathered at first hand by the student.

Movie Actors Skate on Hypo "Ice." Ice-skating in the movie-dramas isn't done on ice at all. The Hollywood climate is too balmy. Chemists have come to the rescue, and photographer's "hypo" has been substituted for the ice.

For example, the motion-picture director is desirous of staging a supposed Canadian championship skating tournament. Following the suggestion of Prof. Arthur R. Maas, industrial chemist of the University of Southern California, he now buys a ton or two of hypo. The chemical is spread about the premises, groomed with a hot iron, cooled, and is ready for the skaters. All of the fancy stunts done on ice seem equally well performed on hypo, and the movie patron doesn't know the difference.

Hypo is known to chemists as a compound of sodium thiosulfate with a considerable quantity of water. At normal temperatures it is a dry, glassy, but somewhat soft solid of much the same texture as ice. Unlike ice, however, it melts at 118 degrees instead of 32. At the elevated temperature it dissolves in its own water of crystallization, and is easily applied to the surface which is to represent a frozen lake.

Under the pressure of the running skate hypo is scored much as ice. Semi-transparent flakes and grains fly into the air during the course of the movie-drama. Under the eye of the camera the delusion is almost perfect. At the end of the day, a gentle sprinkling, followed by a hot iron, restores the fake ice to its pristine luster.

The use of the crystalline thiosulfate has been proposed for amusement rinks, but would likely have too stiff a competition from artificial ice as now employed. On the vaudeville stage, as well as in the movies, it has been successful. It is possible that some new and cheaper material of moderately high melting point may be brought forth to displace ice, thus eliminating the high cost of refrigeration.—*Science Service*

TEXTILES FROM TEST TUBES. IV. TEXTILE FABRICS MAINTENANCE

PAULINE BEERY MACK, PENNSYLVANIA STATE COLLEGE, STATE COLLEGE, PENNSYLVANIA

The modern chemist has not only learned how to spin gorgeous textile fibers from solutions with which he has experimented in test tubes, but he has also learned how to maintain fabrics and cause them to give the maximum of service. He has studied all fibers carefully, be they man-made or natural, and has found out their response to various cleansing agents. As a result, everything from gloves, hats, shoes, dresses, suits, and fur coats, to window curtains, rugs, overstuffed furniture, and the interior of an automobile can now be refreshed and made as clean as new.

The River for a Wash Basin

In olden times, the family clothing was washed in the nearest stream of water, without the use of any soaps whatever. Soap was not known until comparatively recent times. A pounding action (achieved sometimes by the use of the bare feet) served to float some of the dirt out of the fabrics. In some remote parts of the world, even to this day, the family washing is done in a stream of flowing water, sometimes with the assistance of a crude wooden wash board. Even in the time of our grandparents, it was a common practice to wash clothing in a galvanized tub, with water heated on top of the stove, and with soap made at home from lye and meat scraps.

Brief History of Soap[1]

Soap as we know it today is the product of the last three-quarters of a century. There are several references in the Bible to material which the old English translators have called "sope," but none of these could have referred to the modern product or anything related to it. Thus, in *Jeremiah* **2**:22, we read:

"For though thou wash thee with nitre and take much sope, yet thine iniquity is marked before me."

And in *Malachi* **3**:2, the following is to be found:

"—for he is like a refiner's fire, and like fuller's sope."

In the first of these references, the commentators tell us that the word in the original Hebrew version of the Bible which has been translated as sope is *borith*, which they have reason to believe was used to refer to wood-ash alkali. Although the ancients did not know it, the ash left after wood is burned consists essentially of sodium and potassium carbonates. They found out by accident that the liquor obtained by leeching wood

[1] A considerable portion of the section devoted to the history of soap-making is taken from Beery's "Chemistry Applied to Home and Community."

ashes in water had a detersive or "dirt chasing" action, and they made the most of their find.

In the second reference quoted above, *fuller's sope* unquestionably refers to fuller's earth, a clay of a special texture used by wool spinners and weavers of ancient times as a grease absorbent.

In the writings of Pliny the Elder, in the first century A.D., a description is given of the preparation of a crude soap from goat's tallow and beechwood ash. This is one of the first historical references to the making of a detergent by the action of an alkali upon a fat. Assuming that the goat's tallow is largely composed of stearin, and assuming that the alkali present in beechwood is composed chiefly of sodium carbonate, the following equation represents the reaction which probably took place in the preparation of this early type of soap:

$$\begin{array}{l} C_{17}H_{35}COOCH_2 \\ | \\ 2\ C_{17}H_{35}COOCH \\ | \\ C_{17}H_{35}COOCH_2 \end{array} + 3Na_2CO_3 + 3H_2O \longrightarrow 6C_{17}H_{35}COONa + 2 \begin{array}{l} CH_2OH \\ | \\ CHOH \\ | \\ CH_2OH \end{array} + 3CO_2$$

One of the earliest uses of the soap which Pliny describes was as a hair pomade. Later it came to be used for laundering fine linen and laces. It did not come into general use for laundry and toilet purposes until the last two or three centuries.

The Soap and Candle Maker

In the early history of our own country the extraction of lye from wood ashes, and the boiling of this alkali with the fat remnants from the kitchen was a common household task. The first step toward taking soap-making away from the home was made by the early soap- and candle-maker, who went from house to house collecting fat scraps, which he rendered in an open kettle. The tallow derived from this operation he used in making soap and candles which he offered for sale.

Since carbon dioxide is evolved when carbonates and fats react, the reaction is unsatisfactory because of the frothing which takes place. On this account soap-makers early began the practice of converting the carbonates obtained from wood ashes into the hydroxides, thus using the hydroxides in the saponification reaction. For causticizing wood ashes, lime was used, and the reaction taking place was the following:

$$Na_2CO_3 + Ca(OH)_2 \longrightarrow 2NaOH + CaCO_3$$

The Alkali Industry Advances

The manufacture of soap on a large scale, however, was impossible so long as the supply of alkali was limited to wood ashes. In 1791, Le Blanc,

a French chemist, made available a cheaper and more extensive supply of sodium carbonate by introducing a method of making soda from common salt. The introduction of the Le Blanc process, and, a few years later, of the Solvay (soda-ammonia) and the electrolytic processes, solved the alkali problem and made possible the extension of wholesale soap-manufacturing. Some manufacturers at the present time causticize their own carbonate by a process similar to that mentioned above; others buy the sodium or potassium hydroxide ready for use as such.

Classic Work of Chevreul

Until the work of the French chemist, Chevreul, however, soap manufacturing was done more or less by rule of thumb. This chemist carried out extensive researches between the years 1811 and 1823, and discovered for the first time the exact chemical structures of fats and of soaps. Many of the natural fats, such as stearin and olein, were analyzed and named by him. After these classic researches were published, it was possible to make soap by adding definite quantities of reagents according to actual combining proportions, rather than by the hit-and-miss methods formerly employed.

Soap by the Chunk

In the early days of soap manufacture, little attention was paid to the appearance of the article. The manufacturer supplied the grocer with large blocks of soap from which pieces of varying sizes were cut as the consumer desired. With improvements in the manufacture of machinery used in soap making, and with an increasing interest in trade-marks, more attention has been given of recent years to the appearance of the soap put on the market.

Factors Contributing to Growth of Soap Industry

The factors responsible for the very rapid development of the soap industry in recent years may be summarized briefly as follows:

(1) The researches of Chevreul disclosed the fact that soap is the sodium or potassium salt of a higher fatty acid. Before the chemical structure of soap was known, the product could not be made in anything like a scientific manner.

(2) The discovery of cheap methods of producing alkali from salt and other cheap raw materials made it no longer necessary to depend upon wood ashes as the sole source of supply.

(3) The growth of wholesale meat packing establishments placed more fat on the market than was available before that time.

(4) Improvements in soap-manufacturing machinery increased the rate of output possible.

(5) Introduction of methods for recovering glycerine made it possible

for this valuable by-product to help pay the cost of manufacturing the main product.

(6) The rapid growth of the cottonseed industry increased the quantity of fat available.

(7) Introduction of methods of hydrogenating fats made it possible to utilize cottonseed oil and other liquid oils by converting them chemically into products with higher melting points. This placed more of the solid fats on the market.

Hydrogenation of Fats

Fats and fatty acids decrease in melting point as they increase in number of double bonds to the molecule. If, for example, two fats, or two fatty acids, each with the same number of carbon atoms to the molecule, should be compared as to the melting point, the fat or the fatty acid with the greater number of hydrogen atoms to the molecule would be found to have the higher melting point. This relationship may be shown by comparing the melting points of typical fats:

Fat	Melting point
Beef tallow (high percentage stearin, a saturated glyceride)	40 to 45°C.
Cottonseed oil (high percentage olein, a glyceride containing one double bond per molecule)	3 to 4°C.
Linseed oil (high percentages each of linolein, a glyceride containing two double bonds per molecule, and linolenin, containing three double bonds per molecule)	−20°C.

Oils which for years have been worthless in making soaps because of the soft consistency of the product can now be changed from unsaturated to saturated compounds by the addition of hydrogen atoms to the molecule. This process, known as *hydrogenation of fats*, consists, briefly, of bringing the oil, which is vaporized by superheated steam, in contact with hydrogen in the presence of a catalytic agent. Many patents have been granted covering the use of various catalysts for this purpose. A number of metals and of compounds of metals may be used for this operation. The catalyzer is itself not changed at the end of the reaction. The hydrogenation of fats, if carried to completion, may be represented by the following equations:

$$\begin{array}{l} C_{17}H_{33}COO{-}CH_2 \\ | \\ C_{17}H_{33}COO{-}CH \\ | \\ C_{17}H_{33}COO{-}CH_2 \end{array} + 3H_2 \longrightarrow \begin{array}{l} C_{17}H_{35}COO{-}CH_2 \\ | \\ C_{17}H_{35}COO{-}CH \\ | \\ C_{17}H_{35}COO{-}CH_2 \end{array}$$

Olein → Stearin

$$(C_{17}H_{31}COO)_3C_3H_5 + 6H_2 \longrightarrow (C_{17}H_{35}COO)_3C_3H_5$$

Linolein

$$(C_{17}H_{29}COO)_3C_3H_5 + 9H_2 \longrightarrow (C_{17}H_{35}COO)_3C_3H_5$$

Linolenin

$$(C_{17}H_{27}COO)_3C_3H_5 + 12H_2 \longrightarrow (C_{17}H_{35}COO)_3C_3H_5$$

Clupandonin

Talgol and Candelite are two of the trade names applied to hydrogenated fish oil. This oil loses its odor upon being hydrogenated, and is suitable for use in conjunction with other fats in making various kinds of soaps. Linolith is a trade name applied to hydrogenated linseed oil.

Cottonseed and Peanut Oils Rival Hogs

At the present time, 300,000,000 pounds of oil are hydrogenated annually in the United States by catalytic processes. This produces fat equal to that obtained from 7,000,000 hogs. A still greater quantity of fat not itself hydrogenated is modified to advantage by blending it with hydrogenated fat. The soap industry, therefore, which before 1900 was seriously hampered by the demand for all edible fats for use in the manufacture of food products, is now able to expand because of the increased quantity of solid fats placed on the market by this process.

A Brief History of the Power Laundry

The development of the power laundry is of still more recent origin than that of soap manufacture. George Johnson, a research fellow of the Laundry Owners' National Association, working at the Mellon Institute for Industrial Research, Pittsburgh, gives us the following brief outline of the history of the power laundry in his book on "Textile Fabrics:"

Cholera and the Laundry

During the nineteenth century laundering was first developed as an industry. In 1832 cholera broke out in London. After a time it was noted that the scourge had its greatest mortality in the dirtiest sections of the city and that cleanliness was required to combat the disease. One laundering establishment was opened at once, and in 1842 a more business-like plant was started in Liverpool, followed by two others in London. In 1846 Parliament passed an act authorizing the establishment of laundries from the public funds.

The Detachable Collar Starts an Industry

In America, the laundry industry was originated about 1827 with the invention of the detachable collar. Nine years later, Independence Stark, a manufacturer of Troy, N. Y., established a laundry to take care of the product of his own factory and of near-by collar makers. As far as records show, the first American laundry, as one thinks of laundries today, came into existence in 1851 as the Contra Costa Laundry at Oakland, California. It was started for the purpose of washing the clothing of the men who were attracted to the West by the gold rush. The walls of the building in which the first laundry of record was operated may still be seen, having been permitted to stand when the plant was enlarged some years ago.

Washing Machines from Barrels

The first washing machines were made of half-barrels, in which the soiled clothing was placed and washed by means of agitation. The agitator was a crude affair made of wagon-wheel spokes. Although it is not stated in the history of the first laundry, it is presumed that the power applied to the agitators was that of brawny, masculine

arms. The water was squeezed from the clothes by a crude home-made wringer, the drying process being that of the old-fashioned clothes line.

The First Rotary Washing Machine

In 1858 an inventor conceived the idea of washing clothes by machinery, and in the following year the first rotary washing-machine was made by Hamilton E. Smith at Pittsburgh, Pa. The inventor soon discovered that his machine did not operate efficiently, and it was not until 1862 that he obtained a patent. During the next year he secured patent protection on the first self-reversible motion attachment to the machine. The first steam laundry in the true sense of the word was fitted up for operation in 1863 at Pittsburgh at the St. Charles and Monongahela House. From 1858 to 1873 this same inventor (Smith) experimented with an ironing machine, as a result of which the present-day flatwork ironer has been developed.

The Family Wash and the Power Laundry

For a number of years after the establishment of power laundries, laundry service was confined to the renovating of men's garments, starched pieces, and hotel and restaurant linen. It was not until about 30 years ago that family washings first found their way into the public laundry. It has been stated that the first families to patronize the public laundry were located in the mill districts of New England. This patronage was due to the fact that textile mills drew so heavily upon the supply of female labor that it was impossible to find washwomen to come into the homes to do the weekly washing. The solution of the New England housewives' problem of handling the washing, namely, the sending of soiled pieces to the laundry, has gradually spread all over the country, until in the last five years the laundry business has become more than a half-billion dollar enterprise. It is estimated that the total annual volume of laundry work will exceed one billion dollars by 1930.

Although thirty years ago power laundries were doing practically no family work, at present about 15 per cent of the families of the country are patronizing commercial plants. This increase in business is an indication that the nation's home managers will soon handle their wash-day burdens largely as they are handling their spinning and baking problems; the work will be done away from the home.

Maintaining Silks, Rayons, Woolens, and Furs

It was a sad event, indeed, when a lady of ancient or medieval times soiled her best silken garment. The best that could be done under the circumstances was to take out as much of the stain as possible with water, and allow the rest to stay in. Water had a detrimental effect on many of the fine fabrics, but it was the only cleansing solvent known.

In the late seventeen hundreds, a deliberate search was made for solvents suitable for cleaning ladies' court dresses without damage to them. In 1825, Michael Faraday first discovered benzene, a product well-known today in the dye and other chemical industries. A short time after this, Jolly Belin, a Frenchman, discovered that benzene would remove grease from textile fabrics.

The First "Dry"-Cleaning Solvent

This discovery marked the beginning of the dry-cleaning industry. Belin kept his discovery secret, and passed his business down to his son-

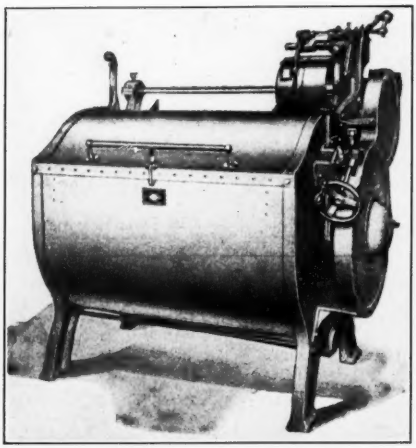
EXTERIOR OF NATIONAL ASSOCIATION INSTITUTE OF DYEING AND CLEANING AT SILVER SPRING, MARYLAND
(SUBURB OF WASHINGTON, D. C.)

Here, theoretical and practical training combine to give the cleaner and dyer the ability to cope with modern textile maintenance problems.

in-law, who established the firm of Petit Didier in Saint Denis, near Paris. Gradually the secret of the process leaked out, and other plants were founded in Austria and in Germany.

After the discovery of methods of making synthetic dyes from benzene and its derivatives this compound came to be in such great demand that it was no longer economical as the chief solvent in the dry-cleaning industry. Up until about 1869, therefore, camphene (another organic solvent) was the chief dry cleaning reagent used.

Camphene presented two chief difficulties. In the first place, it was highly explosive, and in the second, it was necessary to rip the garment almost entirely apart in order to use it properly.



Courtesy Gross Machinery Co., Buffalo, New York

A DRY CLEANING WASHER MADE OF A SPECIAL NON-CORROSIVE NICKEL ALLOY

These machines vary in length from 2 or 3 feet for hats and gloves, to 15 or 20 feet for rugs and carpets.

Petroleum and Dry Cleaning

It was not until some time after the Civil War that it was found that some of the volatile products derived from petroleum could be used in the cleansing of fabrics. The first oil had been struck on August 29, 1859, and the first well dug shortly thereafter at Titusville, Pennsylvania. But it required a number of years before the distillation of crude petroleum was developed very fully.

Even with the advent of gasoline and other volatile solvents derived from petroleum, the dry-cleaning industry was not in a position to make much progress until the development of suitable dry-cleaning machinery and of soaps which are soluble in dry-cleaning solvents. By 1900, garment-cleaning machines, hydroextractors, solvent purification systems, and suitable soaps had come on the market.[2]

The Modern Dry-Cleaning Process

In the modern dry-cleaning plant, all pieces of equipment used in the dry-cleaning process proper are attached to one continuous line—the wash-

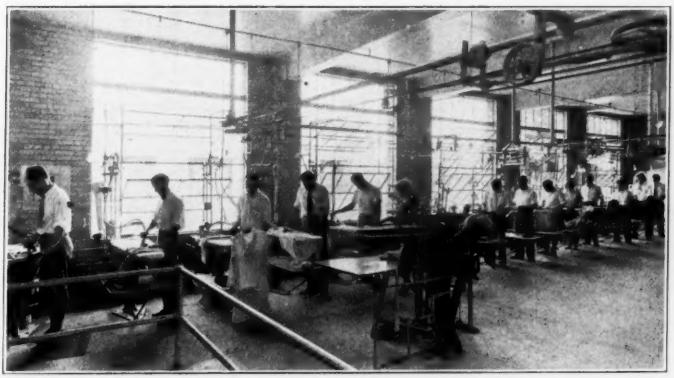
[2] Much of the information concerning the history of dry cleaning was taken from C. C. Hubbard's book, "The Instructor in Garment Cleaning," and from lecture notes which the author of this article jotted down while taking the course at the Institute of Dyeing and Cleaning at Washington, D. C.

ers, the extractors for removing the solvent from the fabrics, the devices for clarifying the solvent, the storage tanks for solvent, etc. In a system of this sort, the same solvent can be used over and over again. One or a combination of more than one of the following methods of purification may be used:

(1) a vacuum still;
(2) a centrifugal device;
(3) underground tanks containing caustic soda solution;
(4) filter presses.

Standard Dry-Cleaning Practice

According to the standard practice adopted by the National Association of Dyers and Cleaners, as a result of extensive research on the subject, the



THE SPOTTING AND FINISHING DEPARTMENTS OF THE INSTITUTE AT SILVER SPRING, MARYLAND

fabric being handled goes through the following steps, after the garments are sorted as to kind and color:

(1) It is placed in a metal washer. Silks and delicate fabrics are placed in meshwork bags to prevent damage from abrasion. The articles are first agitated for ten minutes in clear solvent. The continuous system is turned on and solvent is allowed to flow through the machines until it is clear.

(2) The machines are opened and a special liquid soap which is soluble in dry-cleaning solvent is introduced. The machines are again turned on and agitated for five minutes, after which the continuous system is turned on and allowed to flow until the solvent comes out of the washer clear.

(3) If silks are being run, they are then removed from the washer, ex-

tracted, and given a hand sponging with special soap solutions. They are then returned to the washer.

(4) To the solvent in the machines, a special alcohol-containing soap is added, and the fabrics are again agitated for five minutes.

(5) A final rinse with the continuous system turned on takes place until the solvent is clear.

After the thorough cleansing given the fabric in the dry-cleaning process, it is relieved of solvent by a centrifugal process, and is dried in a current of mildly warmed air. This volatilizes and evaporates the solvent, leaving the garment ready for the *spotting* and *finishing* processes.

STRETCHING A DRESS OVER A RUBBER FORM INFLATED BY COMPRESSED AIR, AND SIZING IT TO MAKE IT HOLD THE INCREASED DIMENSIONS

Spotting

After the garment has been carefully and thoroughly dry-cleaned, a number of refractory stains may require special treatment. The garment is therefore inspected and sent to the "spotting" department. In this department, trained experts use whatever special reagents are required for each stain treated. Care is taken in each case to use no solvent which will weaken the fiber or remove the color of the particular fabric in question. Each "spot" is a different problem and requires special consideration.

Spotting is carried out on specially designed and constructed porcelain-topped spotting boards. The board is so constructed as to make everything as convenient for the worker as possible. The garments are handled with extreme care in every case. The removal of spots and stains on different types of fabrics is highly technical, and is growing even more so every day.

For the removal of the ordinary stubborn stains and soil spots on garments, which do not yield to the standard dry-cleaning process, dry-cleaners formerly used a limited number of *special* solvents. The more recent advent of the synthetic fibers, however, has presented new problems. Some of these, particularly those with subdued lusters and beautiful designs, were found to be seriously injured by the older spotting reagents. As a result the research department of the National Association of Dyers and Cleaners has replaced old methods and injurious solvents with new and safe methods of treatment and safe reagents.

Finishing

The finishing of garments is also a highly technical operation. An electric iron, for example, is not always used on many of the beautiful new fabrics worn so extensively today. A steam iron, maintained at a certain constant temperature and provided with perforations through which small jets of steam may issue forth and permeate the garment is frequently used on many of the new, fashionable afternoon and evening gowns as well as to replace plaits in many others.

SUNBURST PLAITS, PUT IN WITH A SPECIAL STEAM IRON

Special so-called "puff" irons are used in the finishing department of a dry-cleaning plant to finish gathers, ruffles, smocking, and the like. Special steam boards for velvets, and special finishing equipment for ties, for gloves, and for hats are also found in most good plants.

Men's garments are finished in certain plants on special pressing machines so constructed as to "fit" each part of the garment and to produce a piece of work which could not be matched at home with an ordinary ironing board.

Worn or chafed fabrics often have their luster restored by treating with small amounts of a sulfonated oil (monopole oil). Every garment presents a new problem, which the expert finisher has to work out.

What the Master Cleaner Can and Cannot Do

Nowadays almost anything of a fabric nature can be dry-cleaned safely, its original brightness restored, and its beauty refreshed and renewed. Recently, for example, a Master Cleaner received a musical toy dog which had been the favorite source of amusement for a small boy. Badly soiled and with the chiming apparatus stopped, the toy was sent to the cleaner. Not only did the dog come back thoroughly cleaned and

sterilized, but the solvent had removed the gummy soil from the inside of the musical instrument and it chimed again like new, to the delight and happiness of its small owner.

The Master Cleaner can clean almost anything of a fabric nature, from fur coats to kid gloves; from automobile upholstery to neckties; from a miniature lamp shade to Roxie's mammoth rotunda rug in the new picture house in New York City.

Here is a list of dry-cleanable articles which was copied from the stationery of a Master Cleaner who is located in a comparatively small city. Other plants in larger cities add many other items to this list, but it will serve as typical of the average good cleaning plant which is a member of the National Association of Dyers and Cleaners.

We clean:

MEN'S

Suits	Sweaters
Overcoats	Bath Robes
Slipons	Hats and Caps

Neckties

LADIES'

Waists	Furs
Skirts	Gloves
Jacket Suits	Sweaters
Dresses	Bath Robes
Evening Gowns	Spats
Kimonas	Hats
Lingerie	Corsets
Coats	Slippers

HOUSEHOLD FURNISHINGS

Draperies	Blankets
Lace Curtains	Comforts
Piano Covers	Rugs and Carpets
Lamp Shades	of all kinds

Upholstered Furniture

MISCELLANEOUS

Interiors of Closed Cars	Slip Covers

Auto Robes

But there are things which the Master Cleaner *cannot* do, and plenty of them. He is no miracle man, with all his skill and knowledge and equipment. He can remove automobile grease and road tar from a dainty silk frock, but he often is unable to remove venous blood stains without some slight damage to the color. He can restore the luster to a gown on which the owner has experimented with soap and water, but he cannot bring back chafed silk or satin that has had the entire finish of the fabric removed by

friction. He can take out coffee or tea stains ordinarily, but if they have been set by the heat of an electric iron, neither he nor a magician can bring the garment back to its original beauty.

Nature is the chief obstacle to the perfect renewal of many garments. Fruit juices, soft drinks, many fruits, and vegetables contain a substance which for want of a better name has been generally classed as tannin. Tannin stains may be washed out easily with plain water in the early stages soon after they are acquired. But let the temperature of the garment be brought up to 130°F., either through contact with the electric iron or otherwise, the chemical nature of the tannin is changed and a brown stain develops. Attempts to remove it by any method known to mankind only result in damage to the fabric. The better Master Cleaner will send this stain back to you untouched and will usually advise the owner that any attempts to remove tannin stains in the home or in a perfectly equipped plant will result disastrously to the garment.

Soap and water set some stains, as the alkali in the soap combines with certain types of soil to make a relatively insoluble product. These are comparatively few in number; nevertheless, they present great difficulty.

Perspiration stains, if allowed to remain in a fabric for any length of time, or if exposed to direct sunlight for some hours, weaken the fabric to a point where cleansing is impossible without damage or complete ruination. If left in the garment for several months, the acid in perspiration forms a permanent stain. The acid also has an effect on certain types of dyestuff, and the only remedy for faded colors under the arms of certain garments is skilful spot dyeing, the most difficult of all the dyer's arts.

Cleansing Weighted Silks

True silk, or worm silk, as it arrives from the Orient is covered with a gummy substance which often equals 22 to 27 per cent of its weight. This must be removed before dyeing, and as the traffic in raw silk is entirely by weight it has become a general practice to restore a certain amount of this loss by adding tin or iron salts, a process generally termed metal weighting. As competition in recent years has increased, this weighting practice has gone up to as high as 75 per cent of the original weight of the thread. True enough, the metal weighting gives drape and luster to the garment, but the addition of large quantities of these foreign substances presents a problem to both consumer and dry cleaner which is almost impossible of solution. Perspiration combines with the tin and iron to form a metallic salt, and in the process the fiber itself may disappear. Damage of this sort is usually characterized by straight splits or breaks in the fabric, and a test can usually be made to prove the presence of metal weighting by burning a piece of the selvage or hem. If a fabric is heavily weighted, the original form and

shape of the sample so tested will remain after the fiber itself has burned out. Stains on heavily weighted silks are hard to remove safely.

The Master Cleaner will usually advise the customer that he is unable to remove such a stain. Many times, however, he does not find it out until the garment reaches the first cleaning process. Then the customer is generally advised, and the cleaner goes ahead with the job only at the owner's risk. This is fair and equitable to both parties and should command the consumer's respect.

Sizing in Garments Presents Difficulties

Recently, a new complication has entered into both the manufacture and maintenance of garments and draperies. In addition to the tin and iron salts which have been used in the weighting of fabrics, certain manufacturers, seeking to meet the price situation, have dressed their fabrics with paraffin, rubber, insoluble starch, and other temporary sizings. Upon immersion in either a dry or wet cleaning bath, these sizings either dissolve or change form. Contact with a solvent-and-soap solution may also change the color and permanently stain the fabric, amounting in fact almost to dyeing it. These difficulties usually present themselves in garments of cheaper grades.

The consumer should therefore not be surprised if the practice is begun of accepting such garments only at the owner's risk. These sizings also permit holding the fabric to abnormal dimensions and when the sizing is removed shrinkage results. Crepes and georgettes suffer most from this practice of adulteration.

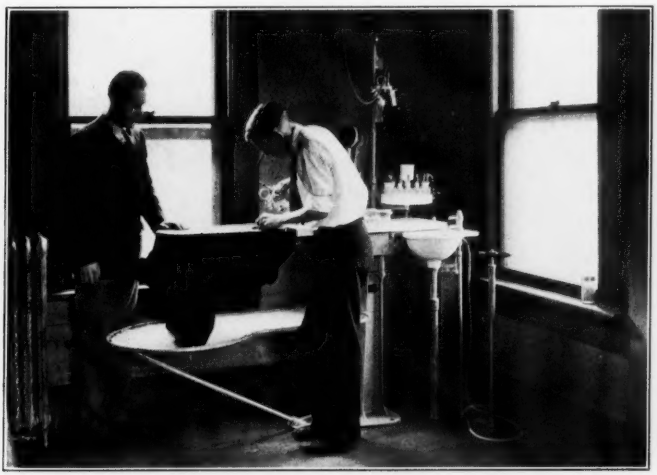
The Master Cleaner and the Synthetic Fibers

The advent of the rayons has spread the use of lustrous garments to all classes of women in our own and other countries. It has made it possible for the Sunday silk of yesterday to become the universal garment for work and dress and play today. It has increased clothes consciousness and raised the standards of the inhabitants of the world, for both men and women are affected by the growing flood of man-made fibers in both under and outer wear. Eventually, with the improvement of machinery and processes, and the growth of demand, the output of the synthetic fibers will far exceed the volume of fabric manufactured and sold from natural vegetable and animal fibers. They likewise add new beauty both to garments and household furnishings.

Obviously the new synthetic fabrics are different from the time-honored silk and woolen fabrics, and their maintenance has presented a temporary problem to many dry cleaners and laundry owners. Certain physical characteristics not found in the natural fibers make changed practices necessary in their cleansing.

The rayons of alkaline base are found, in many instances, to weaken appreciably when wet. Care is therefore necessary in handling them to avoid damage. This problem is now being solved. Fibers from an acetate process, such as Celanese and other cellulose acetate products, may not be cleansed or spotted with strong solutions of certain solvents, such as acetone, acetic acid, or alcohol.

At first dry cleaners were hostile to the new synthetic fibers and in some cases took united or coöperative action to refuse to accept responsibility for them in the cleansing process. The National Association of Dyers and



Students at the Pennsylvania State College Who Expect to Become Dry Cleaners Take a Special Course in Textile Chemistry in Their Senior Year

Cleaners, however, has taken the stand that man-made fibers are here to stay, and it is therefore definitely committed to the policy of encouraging their use and instructing their members in the proper maintenance of the beautiful fabrics made from them.

A State Textile Maintenance Program

The State of Pennsylvania, through the agency of the Textile Chemistry Department of the State College, has coöperated with the laundry and dry-cleaning interests of the state in a textile maintenance program. In furtherance of this program, the author of this article was sent to the Institute at Silver Spring, Maryland, in order to learn more about the professional refreshment of textile fabrics. Since the completion of the course there, she

has assisted in consumer education and in the training of chemistry students who wish to go into one or the other of the textile maintenance industries. The states of Iowa, Texas, and Kansas have already made arrangements for sending members of their staffs to the Institute, and other states will follow suit shortly.

Moth-Proofing

Much interest has been shown of late in the subject of moth-proofing. Many moth-proofing preparations are on the market for the use of private housewives, but little is known about their composition or their effectiveness.

The only moth-proofing preparation which has been completely described

THE CHEMISTRY LABORATORY AT THE INSTITUTE OF DYEING AND CLEANING, SILVER SPRING, MARYLAND

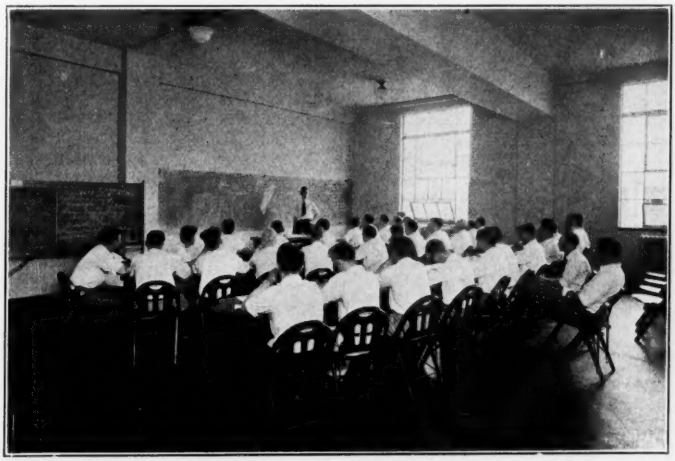
in the literature was developed at the Mellon Institute of Industrial Research by Lloyd Jackson and Helen Wassell. A complete description of the experiments of these two research workers may be found in *Industrial and Engineering Chemistry*, **19,** 1175 (Oct., 1927). The workers set for themselves, in advance, the following standards for the preparation which they hoped to develop:

(1) It must be inodorous.
(2) It must adhere evenly to the fiber treated like a dyestuff.
(3) It must be unrecognizable on the fiber.
(4) It must not dust off.
(5) It must not affect adversely the physical properties of the textile fibers.
(6) It must be soluble in inexpensive organic solvents, such as petroleum naphtha, as well as in water.
(7) It must have no untoward physiological action; that is, it must be non-toxic to human beings.

(8) It must repel clothes moths.
(9) Its cost must be reasonable from the industrial viewpoint.

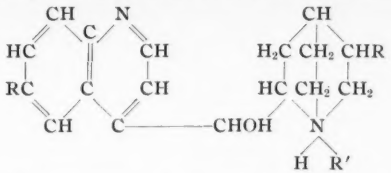
About one hundred chemical compounds and some seventeen different combinations of compounds were actually tried on woolen test pieces infested with moth larvae.

The material which the investigators found to meet with the qualifica-



A CHEMISTRY RECITATION AT THE INSTITUTE OF DYEING AND CLEANING, SILVER SPRING, MARYLAND

tions placed upon it was a cinchona alkaloid—a remote relative of quinine, belonging to a group of compounds of the following formula:



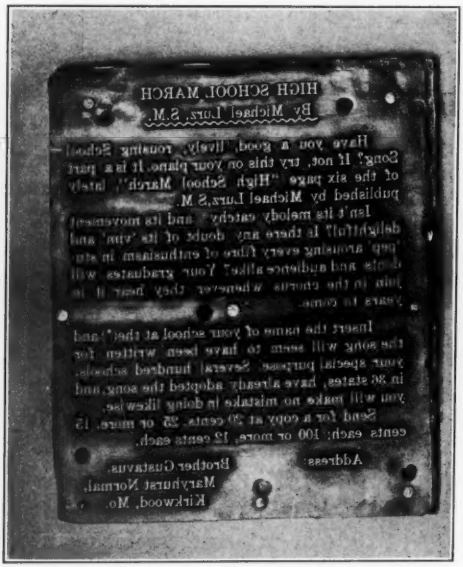
Within the past few months, the use of the process described above has just been released to any dry-cleaner who wishes to pay royalties for the privilege. The material has been given the coined name *Konate*, and the process of applying it is called "*Konating*." The substance may be applied by spraying or by immersion.

Not only has the chemist worked out means by which textile fabrics may be washed or dry-cleaned in a scientific manner, therefore, but he has worked out means of coping with one of the oldest enemies of one of the most important textile fibers, namely, wool.

AN EXPERIMENT IN ELECTROFORMING*

WILLIAM J. HAMM, MARYHURST NORMAL SCHOOL, KIRKWOOD, MO.

I had been serving as printer's devil in an amateur printshop and had been initiated into all the intricate operations of setting up type and distributing "pie." Naturally, I became very much interested in the process of electrotyping when this subject was touched upon in the chemistry course. Reading material on the process was not overabundant but, once I had begun, I learned by experience. In this article I will describe how I made an electrotype. I think that statuettes, medallions, engravings, and embossings could be reproduced just as easily and in a similar manner. Electroforming can serve as an excellent laboratory experiment to illustrate Faraday's law, ionization, and the fundamental principles of electrochemistry.



ELECTROTYPE FORMED ON WAX IMPRESSION FROM PRINTER'S TYPE

Forming the Impression

I melted a mixture of beeswax and "Gallica" wax, and added to it about one-sixth of its volume of finely powdered graphite. I made a shallow tin box about eight inches square and one inch deep and in this I cast a slab of the wax mixture, embedding in its center a sheet of copper foil. This was later to carry the cathode current. It was of slightly smaller area than the wax slab itself and had a projecting lug for connection. When the wax had solidified, the metal box was readily stripped off. I rubbed into the smooth upper surface of the wax a small amount of powdered graphite until it was well coated and presented a polished appearance. It was now ready to receive the impression of the type-form which was to be electrotyped. To secure the necessary pressure I used a small letter press, placing the chase with the type upon its base, and laying over it the slab of wax which had been

* Winner of ten-dollar award in the student contest closing March 15, 1928.

warmed until sufficiently soft. Pressure was then applied until the impression was sufficiently deep. I found this to be the most delicate part of the whole process for if too much pressure is applied an imperfect or cracked impression results. Lifting the wax "matrix" from the type form presented no difficulty, and, as I had worked carefully, I was rewarded with a perfect impression. Even minute indentations and delicate lines were reproduced faithfully.

DUPLICATE OF A HALF-TONE PLATE

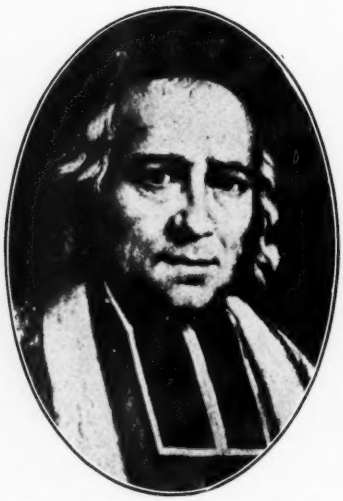
Preparing a Plating Surface

I found it to be essential to success that the entire surface to be plated be rendered conductive by thoroughly coating it with powdered graphite. On a large, smooth surface, I did this with the fingers, rubbing until a slick, glossy finish was secured. To graphitize corners, fine indentations, and irregular lines, such as occur in an impression of a page of type, I made a graphitizing brush of original design. It consisted mainly of a piece of rubber tubing about a foot long, which was made to serve as a flexible shaft. One end of the tubing was attached to the shaft of a partly dismantled tool grinder, and the other to a camel's hair brush. The brush turned loosely in a short piece of brass tubing which could be held in the hand. The revolving brush easily worked the graphite into otherwise inaccessible places. To make electrical contact with the prepared surface, I drove a few small nails into the imbedded sheet of copper foil mentioned above, so that their heads made contact with the graphite surface.

Plating

My plating tank consisted of a large, oblong battery jar. This I filled with a plating solution made by dissolving twenty ounces of copper sulfate in a gallon of water made strongly acid with sulfuric acid. For anodes I used pieces of old copper roofing; almost any scrap copper will do. The prepared wax constituted the cathode. After making sure that all the

cavities in the surface of the wax were "wet" with the solution, I hung the anode copper about two inches from the wax. The current was obtained from two cells of a storage battery and so regulated with a rheostat that only 0.3 to 0.4 ampere per fifty square inches of plating surface flowed through the bath. I regulated the deposition carefully so that the deposited copper would be bright and not too roughly crystalline.



PROOF PRINTED FROM HALF-TONE DUPLICATE

Finishing

After about twenty-four hours of plating, I secured a fairly heavy deposit. Taking the electrotype from the bath, I stripped it from the wax and placed it under water to minimize oxidation of its surface, until I was ready to back it up. I did this with melted type metal, using soldering flux to make the metals adhere. The type metal gives the copper shell strength and rigidity. I mounted the cleaned electrotype upon a block of wood "type-high" and then it was ready for printing.

The illustrations show some of the work I have succeeded in electroforming. The first is a photograph of the electrotype herein described. The second shows the duplicate of a "half-tone" plate made subsequently. A proof printed therefrom is also shown.

The field of electroforming is full of opportunity for the ingenious experimenter. A neat embossing, reproduced in copper, lacquered and framed, presents a very artistic appearance and makes an ideal gift. For one who would wish to do more, the reproduction from plaster or gelatin casts of carved busts or statuettes would furnish matter for a very enjoyable and profitable hobby. For me it was an experiment that greatly increased my interest in chemistry and stimulated me to further study.

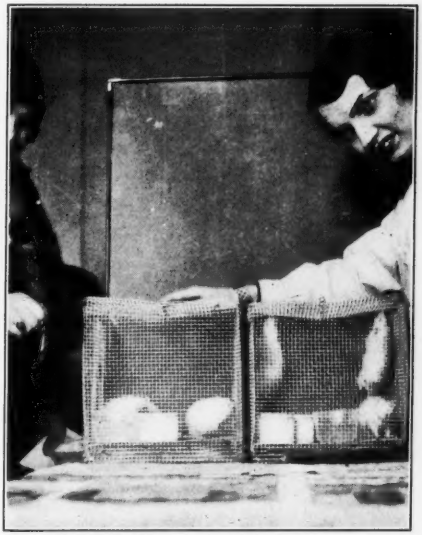
To look fearlessly upon life; to accept the laws of nature, not with meek resignation, but as her sons, who dare to search and question; to have peace and confidence within our souls—these are the beliefs that make for happiness.—MAETERLINCK

THE SCIENCE CLUB OF CEDAR CREST COLLEGE*

LUCY VAN SYCKLE, CEDAR CREST COLLEGE, ALLENTOWN, PENNSYLVANIA

The Science Club of Cedar Crest College began with a poor start this year, having been "shelf-worn" and forgotten by even its members. Then it was suddenly revived by a new movement. Thus, with a great desire for knowledge and proof of some of the vitamin A theories now advanced, the club began an experiment with albino rats which has proved successful in stimulating interest.

Being short of funds, the society decided to build its own cages, for which one-quarter-inch mesh galvanized iron wire was purchased at the hardware store. The store cut it into strips ten inches by forty inches, which were bent every ten inches to form the sides of the cages. The ends were woven firmly together with iron wire. A piece of the mesh wire twelve inches by twelve inches was cut for the bottom, and an aperture, one inch square, cut from each corner of this. Then the sides, bent back one inch deep, gave a ten-inch square which raised the bottom one inch, to allow excreta to fall through. The bottom was readily wired to the sides of the cage. The cover was made of another piece of wire twelve inches by twelve inches with corners cut and bent in the same way. This was cut directly in half, then loosely wired together again, forming a hinge arrangement. Thus the top may be raised and lowered for the purpose of putting in animals or food. The table on which the cages sit is spread with clean newspapers which catch the excreta and are changed daily. The total cost of material for twelve cages was three dollars and eighty-four cents. They were made by girls of the Science Club, a fact which eliminated building expense.



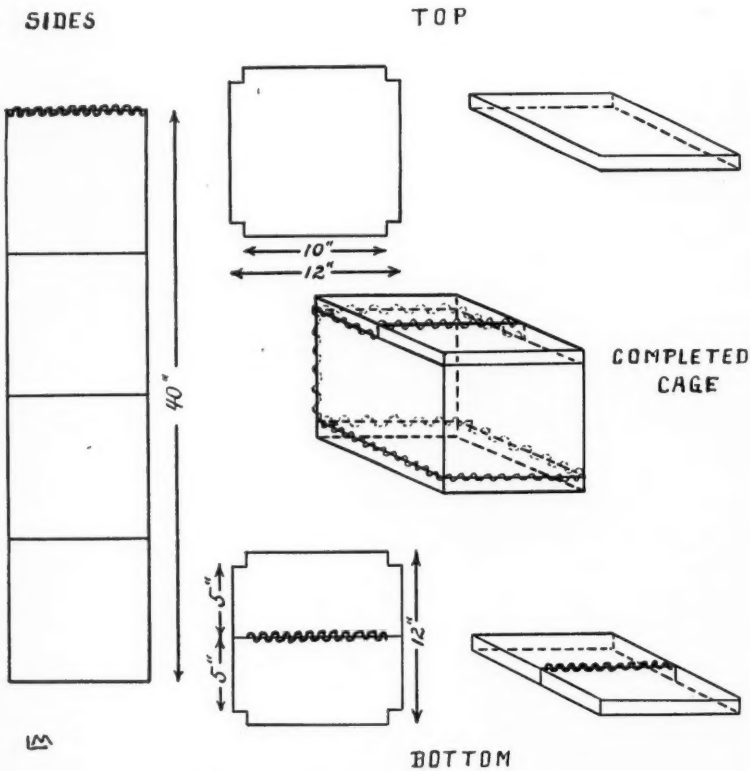
SOME OF THE EXPERIMENTAL RATS OF THE CEDAR CREST SCIENCE CLUB

The albino rats used are of known dietary history and are now feeding on Sherman's diet 379A; namely,

* Winner of five-dollar award in student contest closing March 15, 1929.

67% cornstarch
18% A-free casein
10% dry yeast
4% Osborne and Mendel salt mixture
1% sodium chloride.

This is a vitamin A free diet and depletes the rats' store of A.



DETAILS OF CONSTRUCTION OF THE CAGES

From the group of depleted rats were separated two lots for different experiments. The first lot was given sauer-kraut juice in graduated proportions. A unit dose will be that which gives to a standard animal twenty-five grams growth in eight weeks. This will give an approximation of the amount of vitamin A in sauer-kraut juice since the animals are weighed weekly.

The second experiment is conducted with two parallel groups. The first are healthy rats feeding on Sherman's diet 13; namely,

1/3 whole milk powder
2/3 ground whole wheat
2% of wheat is salt.

These healthy, partially grown animals will be inoculated with bacteria and then tested for the potency of different antiseptics.

Parallel to this a group of vitamin A depleted rats are given the same treatment. The purpose of the experiment is two-fold; it not only determines the efficiency of antiseptics, but also indicates the contrast between a healthy and vitamin A depleted rat in its ability to resist infection.

The preparation of diets for the rats, the feeding, and general care are all voluntarily undertaken by members of the club working in teams of two, so that only a small amount of work is required of any one person. The experiments have encouraged scientific thought among all the students and furthered interest both in this particular study and in the general field of scientific experimentation.

Report of the Water Pollution Research Board for the Year 1927–28.* The objects of the Water Pollution Board are to collect and collate all pertinent scientific and technical information, so that it may be readily available for practical application by those who are concerned with water supply and the disposal of polluting liquids; to encourage and coördinate relevant scientific research in Great Britain; and to undertake such investigations as are necessary in the public interest and not otherwise provided for.

In considering water supply it is proposed particularly to investigate the base exchange or zeolite treatment of water, with special reference to the rate and extent of the base exchange; wastage of material; possibility of contamination of the softened water by silica and alumina; how far the action is a surface one, depending upon size and texture of particles; and the process of regeneration. With regard to sewage disposal, the activated sludge process is to be investigated on biological lines, and in the case of the treatment of industrial effluents a beginning has been made with beet sugar factories effluent, and the experiments, though not yet complete, suggest that a practical solution will be found in biological filtration.

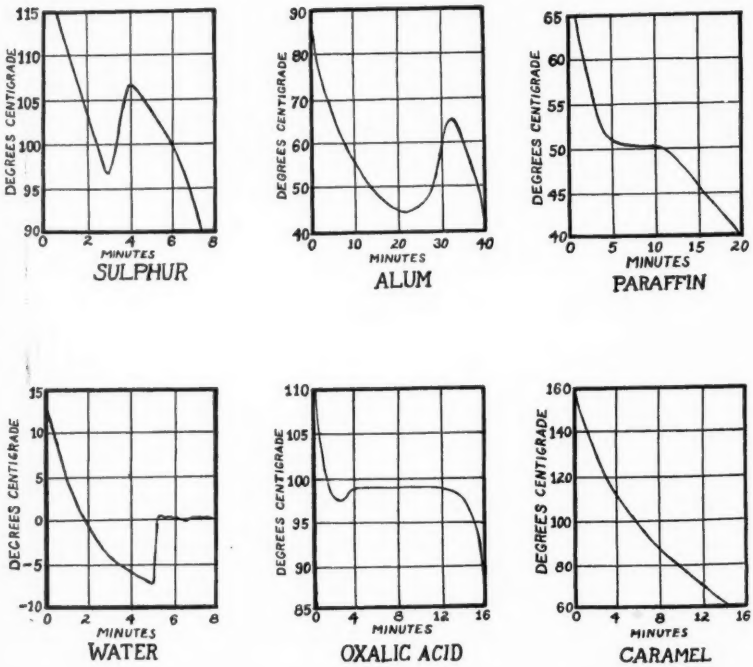
The ideal solution of the problem would be such an alteration of processes that no waste water would be discharged, and, as a rule, less drastic treatment should be needed to render the waste waters fit for re-use than for discharge. The removal of suspended solids by means of detritus tanks, reasonably small; a graded series of mechanically operated and cleaned screens, and finally sedimentation tanks are suggested. Fine screening is not advocated, and punched metal screens would obviate the difficulty of leaves, beet débris, etc., getting entangled in the mesh of woven screens. The sugar and dissolved organic material not removed in such a plant, by gradual accumulation would be liable to fermentation, so that a proportion of treated water would need to be discharged daily and the loss made up with fresh water.—*Analyst*, **54**, 106 (Feb., 1929).

* Obtainable at H. M. Stationery Office, Adastral House, Kingsway, W.C. 2. Price 6d. net.

COOLING CURVES*

STUART GRAVES, WILLIAM NOTTINGHAM HIGH SCHOOL, SYRACUSE, NEW YORK

Among the interesting phases of the study of crystallography is the plotting of cooling curves. The student in high-school physics learns that when a crystalline substance melts a large amount of heat is absorbed. This heat is called the heat of fusion and is expressed in calories. When the substance is again cooled sufficiently to cause it to return to its solid state,



the heat that was absorbed on melting is liberated. This interesting phenomenon can best be studied by means of cooling curves.

The substance to be studied is placed in a test tube or some other suitable container and raised to a temperature considerably above its melting point. A thermometer is then placed in the liquid and readings are taken every half- or quarter-minute while it is cooling and solidifying. When these readings are plotted on a sheet of graph paper we have our cooling curve. In the case of water or other substances which have a melting point below

* Winner of five-dollar award in the student contest closing March 15, 1929.

the atmospheric temperature, the test tube can be placed in a freezing mixture of salt and ice.

When we examine the cooling curve of a crystalline substance, we see that the temperature falls steadily to a point several degrees below the freezing point, rises again to the vicinity of this point, and then continues to fall. By the upward curve we see that heat is liberated when the substance solidifies. The cooling curve of paraffin, on the other hand, shows no such rise of temperature. There is no real solidifying point, but just a range of temperature through which the substance slowly hardens. This is called an amorphous substance. By merely looking at the cooling curve of caramel, we can tell that it is a substance that changes slowly and steadily from a liquid to a comparatively hard solid. It is very rarely that we find the cooling curves of two crystalline substances that are identically the same, and therefore we can often identify a substance by examining its cooling curve.

THE STUDENT'S TEN COMMANDMENTS*

PRESIDENT JOHN M. THOMAS OF RUTGERS UNIVERSITY

Thou shalt set the service of God and man before thine heart as the end of all thy work.

Thou shalt inquire of each study what it has for thee as a worker for a better world, not relinquishing thy pursuit of it until thou hast gained its profit unto this end.

Thou shalt love the truth and only the truth, and welcome all truth gladly, whether it bring thee or the world joy or suffering, pleasure or hardship, ease or toil.

Thou shalt meet each task at the moment assigned for it with a willing heart.

Thou shalt work each day to the limit of thy strength, consistently with yet harder work which shall be thy duty on the morrow.

Thou shalt respect the rights and pleasures of others, claiming no privilege for thyself but the privilege of service, and allowing thyself no joy which does not increase the joy of thy fellowmen.

Thou shalt love thy friends more than thyself, thy college more than thy friends, thy country more than thy college, and God more than all else.

Thou shalt rejoice in the excellences of others, and despise all rewards saving the gratitude of thy fellows and the approval of God.

Thou shalt live by thy best, holding thyself relentlessly to those ideals thou dost most admire in other men.

Thou shalt make for thyself commandments harder than another can make for thee, and each new day commandments more rigorous than thine own laws of the day before.

* Given in 1909 for the convocation of the University of the State of New York.

A HOME-MADE DRY-CELL*

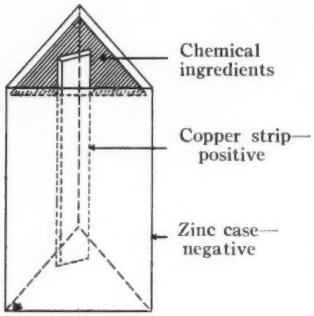
HAROLD L. SCHWENK, SIMON GRATZ SENIOR HIGH SCHOOL, PHILADELPHIA, PENNSYLVANIA

Procedure

A strip of zinc two inches wide and three inches long was folded so that it formed a triangular box one inch wide and two inches high. A three-cornered piece of zinc was then fitted in to form the bottom.

The box was next filled with a mixture of two-thirds ammonium chloride (sal ammoniac), one-sixth manganese dioxide and one-sixth granulated carbon, *i. e.*, powdered charcoal.

A copper strip was then introduced into the center of the zinc case containing the above chemicals, care being taken that the copper strip did not touch the zinc case in any place.



The chemicals in the zinc case were then moistened.

Explanation

The sal ammoniac acted on the zinc, the manganese dioxide prevented polarization or the gathering of hydrogen bubbles on the copper strip as it united with them to form water, and the carbon kept the mixture porous.

Conclusion

This battery, although so very small (one by two inches), when tested with a voltmeter showed one volt and registered half an ampere on an ammeter.

In order to get a current from this cell it was of course necessary to complete the circuit by attaching a wire to the positive pole, the copper strip, and also a wire to the negative pole, the zinc case.

This cell has no practical value but it was made by a high-school student to demonstrate the theory. Any other student can improve his standing somewhat by making one if it coincides with his school studies.

* Winner of five-dollar award in student contest closing March 15, 1929.

The more a man is educated, the more it is necessary, for the welfare of the State, to instruct him how to make a proper use of his talents. Education is like a double-edged sword. It may be turned to dangerous usages if it is not properly handled.—WU TING-FANG

THE TWELFTH EXPOSITION OF CHEMICAL INDUSTRIES

The Twelfth Exposition of Chemical Industries, opening the week of May 6th at the Grand Central Palace, New York City, will continue the previous custom of conducting two series of lectures for students of industrial chemistry and chemical engineering. The lectures arranged are listed below:

Student Lectures

Group I

DISINTEGRATION

Lincoln T. Work, Columbia University, "Grinding."
Pierce M. Travis, Travis Colloid Research Co., "Colloid Mills."

MECHANICAL SEPARATION

Everett P. Partridge, *Industrial & Engineering Chemistry*, "Dust Collection."
Arthur Wright, Filtration Engineers, "Filtration."
H. L. Olin, State University of Iowa, "Filter Aids: Their Nature and Use."

SEPARATION WITH PHASE CHANGE

Philip DeWolf, Goslin-Birmingham Mfg. Co., "Evaporation."

PROCESS CONTROL

Arthur Schroder, Fisher Scientific Co., "Laboratory Apparatus for Controlling Plant Operations."
Richard Rimback, Editor, *Instruments*, "Automatic Process Control Instruments and Devices."
James R. Withrow, Ohio State University, "Temperature Measurement and Control."

UNIT PROCESSES

A. Anable, The Dorr Company, "Conversion of Batch Processes to Continuous."
A. B. McKechnie, Parks-Cramer Co., "Heat Transference with Oil."

MATERIALS OF CONSTRUCTION

S. L. Tyler, Thermal Syndicate, "Use of Vitreosil in the Manufacture of Sulfuric, Nitric, and Hydrochloric Acids."
John R. Townsend, Bell Telephone Laboratories, "Non-Ferrous Materials."

GENERAL ADDRESSES

H. E. Brown, W. M. Welch Scientific Co., "Use of the Element Charts in Laboratory and Works."
W. H. Huson, Carboloy Co., Inc., "Laboratory Side of the Manufacture of Carboloy and Elkonite."
Williams Haynes, Publisher, *Chemical Markets*, "Business Chemistry."

Group II

REVIEWS OF INDUSTRIES

Allen Rogers, Pratt Institute, "An Outline of Recent Advances in the Manufacture of Leather."

J. C. Morrell, Universal Oil Products Co., "Chemical Treatment of Petroleum and Its Fractions as a Unit Process."

A. Gordon King, American Gas Association, "Advances and Tendencies in the Manufactured Gas Industry."

SEPARATION WITH PHASE CHANGE

Henry L. Galson, Philadelphia Drying Machinery Co., "Dryer Development in the Chemical Industry."

PROCESS CONTROL

B. P. Romaine, Weston Electrical Instrument Co., "Electrical Instruments in the Chemical Industries."

Isman Ginsberg, "Automatic Control of Temperature in the Chemical Industries."

MATERIALS OF CONSTRUCTION

Jerome Strauss, Vanadium Corp. of America, "Ferrous Materials."

A CONVENIENT SAND BATH*

The conversion of sodium bicarbonate to sodium carbonate has always given the student considerable difficulty, especially if he used a direct flame to the porcelain crucible containing the bicarbonate salt instead of performing the operation on a hot air bath. The temperature, nine times out of ten, would exceed 300° with the consequent formation of sodium oxide, which, naturally, means erroneous results if it is used for standard acids. As a consequence of this, it was decided to try a sand bath, which gave very satisfactory results. The bath used was a 50-cc. iron crucible (E & A, No. 21272). A 30-cc. porcelain crucible (E & A, No. 21242), containing the sodium bicarbonate, was inserted and surrounded on all sides with sand. After the apparatus had been set up, and the thermometer had been inserted into the bicarbonate and held in place in such manner that the bulb is totally immersed but does not come in contact with the bottom or sides of the crucible, a Tirrill burner was placed under the iron crucible. The heating process continued until the temperature of the salt was 200°, and then the burner was withdrawn. By stirring the salt and keeping the bulb of the thermometer covered at all times, it was observed that the temperature of the salt rose rapidly, then slowly, and finally stopped between 270° and 300° C. By using a flame about one inch and a half high, it was found a simple matter to keep the temperature between 270° and 300°, a condition which was very difficult to obtain otherwise.

G. J. C.

* From *The Hormone*, **3**, 36 (March, 1929).

Correspondence

NEW MOTION PICTURE FILM AVAILABLE

We expect soon to have several copies of a moving picture film on high frequency furnaces. The film will show the melting and pouring of metals in charges of from one ounce to several pounds, clearly indicating the method of operation and the way in which electricity is applied in the furnace charge.

The total length of the reel will be about 800 feet and it can be provided either in standard or in 16 mm. width.

Copies will be available for use at meetings of clubs, schools, and colleges.

AJAX ELECTROTHERMIC CORPORATION
DUDLEY WILLCOX

TRENTON, N. J.

SOME METHODS OF DETERMINING AVOGADRO'S NUMBER

In the February issue of the JOURNAL OF CHEMICAL EDUCATION is published an article entitled "Some Methods of Determining Avogadro's Number" by Arthur A. Sunier. The article seems to be one of the most readable ones on the subject that I have encountered, but the following errors in calculations have been noted.

Page 300, line 22, 8×10^{-23} should read 6×10^{-23}
Page 301, line 37, 313 should read 316
Page 302, line 1, 6×10^{23} should read 4.5×10^{23}
Page 303, line 4, 4.5×10^{7} should read 4.2×10^{7}
Page 303, line 6, 3.1×10^{10} should read 3.3×10^{10}.

Sincerely yours,
CAMILLE HOWELL

VILLA MADONNA COLLEGE,
COVINGTON, KENTUCKY

Editor's Note: The first recalculation listed has revealed a misprint. In all the other cases, however, the discrepancies are only such as would arise from the use of a small slide-rule or by otherwise "rounding off" numbers in calculating.

A VARIANT METHOD OF SOLVING CHEMICAL PROBLEMS

In the March issue of the JOURNAL, page 440, I note with interest an article—"A Variant Method for Solving Chemical Problems"—the contents of which have always been of deep concern to me in teaching chemistry problems, involving weights, to high-school students.

I believe I have a much simpler method which eliminates the step involving the direct proportion, a step which I find is confusing to many students.

Taking an example and proceeding according to the usual chemistry text:

When 40 grams of zinc react with dilute hydrochloric acid, calculate (1) the number of grams of hydrogen liberated, and (2) the number of grams of hydrochloric acid necessary to react with the 40 grams of zinc.

TEXTBOOK METHOD

1.	Zn	$+ 2HCl =$	H_2	$+ ZnCl_2$	4. $\frac{65}{40} = \frac{2}{X_1}$, $X_1 = \frac{80}{65}$ or 1.23 g.
2.	65	2×36	2	135	
3.	40		X_1		$\frac{65}{40} = \frac{72}{X_2}$, $X_2 = \frac{2880}{65}$ or 44.30 g.
	40	X_2			

PROPOSED METHOD

Steps 1, 2, 3 are the same, then the following:

$$\text{Gram wt. given} \times \frac{\text{M. W. unknown}}{\text{M. W. known}} \quad \text{or} \quad 40 \text{ g.} \times \frac{2}{65} \text{ or } \frac{80}{65} = 1.23 \text{ g.}$$

$$\times \frac{72}{65} \text{ or } \frac{2880}{65} = 44.30 \text{ g.}$$

The simplicity of this method is apparent and the ease of solving these problems is evident as we keep in mind only that we multiply the gram weight given by the molecular weights of the unknown substance over the known substance.

ERNEST E. WELLES

EVENING TECHNICAL HIGH SCHOOL,
SCRANTON, PENNA.

Australians Make Paper from Eucalyptus Wood. Australia's paper requirements may eventually be met by the product of native paper mills, although at present all paper used in the commonwealth is imported. Eucalyptus fiber has been successfully made into paper on an experimental scale by two Australian scientists.

Hitherto, attempts at utilizing hardwoods like eucalyptus have not been successful, because the mechanical methods of producing pulp will not work with hardwoods, and the standard alkali processes for producing chemical pulp have resulted in paper that is too bulky, soft, and "short" when tried with eucalyptus. However, a modification of one of the alkali processes has been worked out by the two Australians which gives a paper of satisfactory finish and strength.—*Science Service*

Chemical Digest

THE AMERICAN HIGH SCHOOL

Before the American high school can become the people's college it hopes to be, before it can serve practically all young people of high-school age, there are at least three major conditions which must be met.

First, the process of changing the curriculum, administration, and teaching method must continue apace with the times. The typical high school is still keyed up to the highest third of its students, though not nearly so much so as in the past. The curriculum is still too narrow for twentieth century life and is aimed too much at college preparation. Teaching method is still too rigid and lacking in variety and adaptation. The greater the number that come to school the greater the variety of ability and interest that must be served and the more the high school must exert itself to spread its service effectively.

Second, there must be fiscal changes. The maintenance of the American high school today runs around five hundred million dollars annually. If practically all students should come to school the annual cost would be doubled and hundreds of additional buildings and equipment would need to be provided.

Throughout America practically all the taxation burden falls at present upon real property, until holders of property are crying out for mercy. If America is to continue and expand its policy of providing secondary education for all, the base of taxation must be widened to include other types of property. And there must be a political change. That is, the unit for the levying and distributing of taxes must be enlarged. The district is too small a territorial unit for the support of the high school. It should bear part of the burden but not nearly all of it; the county and state should give substantial help.

Third, and most important, there must be a deeper sense of appreciation. Even high-school teachers do not realize the type of institution they are working in and do not appreciate the opportunity that is theirs. The general tax-paying public does not stop to think—in its hurry and bustle, does not see the high school in all its magnitude and glory. This institution has just grown up in America; it hasn't been consciously planned. The American people do not realize what a giant they have raised. Even parents of high-school students are often blind to the purposes of the high school. Some of them seem to think it just a social institution, just a place where the child should go as a matter of course. Some one asked

Mr. Dooley if he should send his boy to high school and Mr. Dooley answered, "Sure, you don't want him around the house at his age, do you?"

High-school students are notoriously blind to their opportunities. Too many of them think high school is just a pleasant place to loaf, a nice warm place to spend the winter. It is that, of course, but not that mainly. It is a place where life in both its pleasant and its serious aspects is lived and where there is serious preparation for a more complicated sort of life to be experienced later.—*The Flathead Messenger*

THE AMERICAN COLLEGE

The American college at its best is *sui generis*. It has no counterpart in Europe. In its essential quality it is a growth of the soil and spirit of America, and not a replica of the English college. But to traditionally-minded mentors of education, the American college is an ugly duckling. They are puzzled at its small likeness to the European institutions they believe to be its parents. In its awkward, unskilful immaturity, they do not see the growing swan.

So they use power and prestige to transform it into a familiar duck. Failing in that, they turn the creature out to starve, and concentrate their attention upon more proper offspring. Not a great educational foundation in America today is concerning itself vitally with the genius and destiny of the American college as such, except for a few projects lasting over from former policies. . . . .

In America our academic men have an intense feeling of inferiority to Europe. We have not the independent insight to realize that the indigenous institutions our critics hold in contempt are immature stages of growths of novel type and of splendid promise.

The American college is not primarily the home of specialized scholarship where young men and women, having come substantially to an end of youthful development, undertake to pursue to the limit some special field of interest. It is not primarily a professional school, where time and attention are centered on the mastery of a calling. It is not an institution of indoctrination, where some special views of life or religion or politics are impressed upon growing minds, and where the traditions of special peoples or cults are perpetuated.

It is not primarily an institution of instruction, where the daily lesson is a little more advanced than in the secondary school. It is not chiefly a finishing school, where the arts and graces of society are transmitted, and where one receives the authentic stamp of the cultivated man or woman.

It may include many of these elements, but it is not circumscribed by any of them.

The American college is an institution intuitively evolved by the American people, to provide opportunity for the enlarging of life. It is an institution in which incompleteness and provincialism may be cast off, where interest and outlook may become universal, where a larger pattern of life may be set up for emulation. It is a place where crudities may be refined, where discipline may be acquired, where every element of body, mind, character, and personality may be brought under the influence of standards of excellence. It is an extension through a longer time of the period of youth and growth. It expresses the faith of the American people that life may be lived by a larger plan.—*Antioch Notes*

IS THE EUROPEAN SYSTEM BETTER?

Apropos of material we have published from time to time on European Methods of Education, we quote the following from the *Bull. Am. Assoc. Univ. Profs.*, **15,** 150–4 (Feb., 1929).

The Tech, undergraduate news organ of the Massachusetts Institute of Technology, has instigated and fostered a lively discussion of the comparative merits of the European and American systems of university education. Particularly interesting are the opinions of five members of the faculty who have recently studied or taught abroad. Portions of their letters, written at the request of the undergraduate editors, follow:

"My own observations make it exceedingly difficult to avoid the unpleasant conclusion that the product of a European education, taken by and large, is distinctly superior intellectually to the American brand. But I am not yet ready to admit that this superiority is to be traced entirely to differences in pedagogical method. In fact, at times I have rather suspected that the European student triumphed in spite of the system rather than because of it. But there are other circumstances which from the very outset place the European, be he student or professor, on an entirely different footing. Europe caters admittedly to the chosen few, not at all because of a dormant sense of democracy—for America is not the most democratic country in the world—but because of the intense competition. A man must be master of his subject to succeed, and life, even in the secondary schools, becomes a very serious matter. That we in America should strive to raise the intellectual level of the masses is as it should be, not because of any inalienable right of every man to a college education—for we are entitled to things worth while by effort and not by right—but because these very masses are the source of our genius. In our devotion to mediocrity,

however, let us not forget the man who by Nature is superiorly endowed. *It is in this almost universal disregard and neglect of the outstanding man that lies, in my mind, the greatest weakness of the American educational system.*"

JULIUS A. STRATTON

"Active mental life among our undergraduates is quite essential if we are to add to our American educational processes the admitted virtues of European schools. There the student educates himself by aid of lecture attendance, study, and personal conference with his instructors. There is no pampering nor coaxing of the sluggard. Everything depends upon the initiative and intelligence of the candidate. Here at M. I. T. we are in an active process of change aimed at forwarding this process of self-education. (By the way, there is no other method.) Along with a few other schools we are considering our high ranking men and are arranging for honor courses and honor groups. These men are now in a position to obtain very nearly, if not quite, the equal of a European training if they will go after it strenuously and not insist upon carrying a staggering load of student activities of variegated values. But this means probably two things: a year of graduate work in good part devoted to mathematics and mechanics, and the addition of comprehensive examinations at the end of both the fourth and fifth years. Preparing for comprehensive examinations which cover the whole field of pure and applied science studied during the entire college course will compel a coördination and grasp of basic subjects, the lack of which is perhaps the most evident weakness of the American graduate."

HALE SUTHERLAND

"The difference arises from an accumulated tradition of high respect and admiration for intellectual achievement which has been fostered in Europe by centuries of gradual development of culture, and which doubtlessly will some day become a part of American standards. As it is today, one can hardly escape the feeling that many an American university relies more on buildings, athletic teams and claptrap than on high intellectual standards of its faculty and students to uphold its reputation. The great American public's attitude verges on contempt toward the "high-brow" professors whose rôle is neither understood nor properly appraised, perhaps because American educational institutions are not sufficiently careful in the selection of their faculties, more precisely because for financial and social reasons the professor's chair in many cases does not attract the best type of men.

"There is also a good deal of evidence that the purpose of a technical education on this side of the Atlantic is too much how to solve specific problems and not enough how to grasp the general underlying principles on which the solution of these problems is based. The European attitude follows very much the opposite extreme. The average technical student learns general methods, but can he use them to tackle specific problems?

It seems to the present writer that here the faults of European and American methods are fairly well balanced." MANUEL S. VALLARTA

"The European education, in so far as it has advantage over the American, does not, in my opinion possess this advantage by virtue of its differences in detail. What is better depends: (1) on the fact that the European schools receive a smaller percentage of the population, that it is not expected that every young man and woman whose parents have attained a certain minimum of financial solvency shall go to college, and that their universities are not clogged with the enormous mass of ineducables and semi-educables that ruins most of ours; (2) on the fact that the pressure of competition is enormously greater in Europe than here, that a teacher must be a good teacher, an engineer a good engineer, a scholar a good scholar, or they will find their superiors in a long line waiting to take their jobs away from them; (3) that there is an immensely longer tradition of learning, that the scholar is respected, and not treated as here with a toleration which is only not contempt, and that they find it worth their while to allow him that leisure without which intellectual work cannot be accomplished."

NORBERT WIENER

"After I left the university, for a period of twelve years, I did not even suspect the possibility that I ever might be connected with such an institution in a teaching capacity. Therefore, I merely regarded universities as factories destined to furnish animated tools for handling engineering problems, and I valued their merits accordingly. Furthermore, it was my lot to coöperate in succession with graduates from the universities of different countries, including Austria, Germany, France, Russia, the United States, and Turkey.

"My present conception of the possibilities and limitations of university education, largely developed under the influence of these early contacts, and my opinions are the result of definite experience—made under field conditions. *In no case could I discover that the university education was distinctly beneficial to the humbler minds.* As a result of theoretical training, they merely lose what little common sense nature has bestowed upon them—under the European plan much more so than under the American one; this by-product of the university education is very deplorable. *Furthermore, a superficial acquaintance with fundamentals is far more detrimental than none at all.* Hence, for carrying on the routine of construction business, the more intelligent graduates of the ditch, of the construction camps, and of modest trade schools seem to be better fitted than are equally intelligent university graduates. They are keener, better equipped for handling men, and less pretentious. *On the other hand, merely the most outstanding men among the university graduates can be successfully used for handling novel and difficult problems.*

"The fundamental difference between European and American universities

resides in their attitude toward this rather embarrassing situation. *European universities are supposed to exist for the very best minds only. Their function resides in training these minds in productive thought. As a consequence, very little attention is paid to the teaching of mere facts.* Those among the students who cannot keep pace with the teachings are allowed to perish according to their own fashion, and they usually do so at the poor public's expense by entering government service. In brief, the institutions are run according to the principle, '*We must risk boys in order to get men.*'

"In contrast to this, the American universities seem to plead, "*Let's give a chance to every one of these poor boys.*" The poor boys seem to know it; hence, they consider initiative on their own part a waste of energy. It is up to the teacher to fill their vessels while they patiently sit and wait. Since lectures should be within the reach of the feeblest members of the audience, almost anybody may do for delivering them. No wonder the brilliant ones among the students consider the performance rather dull, and they hardly ever get an opportunity to make a serious loading test of their mental capacities! As a result of this system, the average run of the output of the American university is somewhat better than that of the European ones, but the *élite* of the students sadly fails to get the training and the inspiration required for pioneer work. *If in later life such graduates actually achieve prominence, the university cannot claim more than a small fraction of the credit.*

"Thus it seems that both the European and the American systems have their serious drawbacks. It is pathetic to see a European faculty seriously pondering over the scientific achievements of a prospective candidate for teaching an elementary course. It is no less pathetic to see in the United States in charge of post-graduate courses numerous people who never in all their life had an idea of their own. Future development will undoubtedly see a fusion of the merits of the two systems.

"The social and financial position of a university professor in Europe is attractive enough to be desirable even for the most capable representatives of the nation. Hence, the intellectual level of the European faculties maintains on an average a very high standard and justifies the social prestige associated with the membership. The difference between the United States and Europe, as far as the quality of the staff is concerned, consists in the fact that here the M. I. T.'s are very rare, while there, due to the distinguished position of the faculty members, almost every university can afford to live up to a similar intellectual standard. *At European universities complete mastery of the subject invariably represents the minimum requirement for occupying a chair, and ample leisure is provided for keeping track of contemporary developments. This is too rarely the case here in America.*"

CHARLES TERZAGHI

SUPPLY AND DEMAND AS APPLIED TO HIGH-SCHOOL TEACHERS

Before entering upon a discussion of supply and demand as applied to high-school teachers, we might profitably turn to the political economist for a statement of the law of supply and demand. We find it to be stated essentially as follows: "Supply and demand in the market tend always to equality, any tendency to become unequal being immediately made up by an upward or a downward movement." Supply does not mean the total stock or amount, but the actual amount on the market offered for sale. Likewise, demand does not mean the amount of a thing *needed* or *wanted*, but the actual amount taken when offered at a certain price. Using these terms within reasonable limits, Lewis W. Williams, Principal of the University High School, Urbana, Illinois, in a recent issue of the *University of Illinois Bulletin*[1] ably discusses the present oversupply of high-school teachers and the gradual adjustments being made in the demand.

The limiting conditions placed upon the terms supply and demand as defined above may be summed up as follows:

(1) Adjustment is undoubtedly slower when dealing with teachers than when dealing with the usual product of the market.

(2) The demand for teachers is not a constant one, but is, on the other hand, seasonal in nature.

(3) The time element is an important factor. It takes time to train a teacher; not three months, not six months, not even a year or two will suffice.

(4) The higher standards demanded of candidates before they are permitted to teach have resulted in cutting off former sources of supply.

The author justifies his conclusion relative to the present existence of an oversupply of high-school teachers by presenting convincing evidence from his personal experience regarding the large excess numbers of applicants over positions to be filled in various localities and by showing how economic conditions have tended to abnormally increase the supply of teachers.

In discussing the present situation relative to demand, the author brings out the following points:

(1) About a year ago, a principal of one of our prominent high schools stated that although candidates were more numerous than ever before, it was more difficult to find the type of teacher desired. Indirectly, at least, one is justified in inferring that he had, consciously or unconsciously, raised his standards.

(2) There is a smaller turnover of teachers than prevailed six or seven years ago. Another way of stating this same fact is to say that teachers are holding on to their positions more carefully than formerly.

(3) The high-school enrolment, generally speaking, during the last two years has been nearly stationary.

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[1] *University of Illinois Bulletin*, **26** (Feb. 26, 1919), *Educ. Res. Cir.*, No. 50.

(4) School authorities, realizing the situation, are demanding experienced teachers as never before.

(5) There is a tendency to reduce salaries, especially for beginners, in school districts that are dependent very largely upon rural territory.

(6) After three or four years of teaching experience, the usual salary offered is low compared to the beginning salary.

(7) There is an increased demand for men teachers in all departments.

While indications are that the demand is reacting to the supply, it will probably be several years before a satisfactory balance is attained.

Commenting upon the situation as a whole, Mr. Williams stresses the importance of using much greater discrimination than is used at present in the selection of teachers. We quote at length on this point:

To make a more thorough investigation of all candidates, to gain first-hand information if at all possible, and to clear up every reasonable doubt concerning candidates, should be cardinal principles at all times. In my judgment, no principal or superintendent has a more important responsibility than the selection of his teachers. Certainly then, when there is a plentiful supply, he is justified in sparing neither time nor money in fulfilling this obligation. The characteristics most desirable in a teacher should be kept in mind in making the selection. In the first place, the training of the candidate should be thorough. We are not justified in selecting for high-school work anyone who is not a college or university graduate. We should not select specialists in subject-matter, but those who have thorough training in the field or fields in which they are to instruct. In the field of education proper, these candidates should, as a minimum, meet North Central requirements, and, if possible, have had a thorough course in practice teaching. The next thing to be emphasized is character. There are many influences today which, though perhaps not negative, are certainly not in any sense positive or uplifting. Therefore, we are justified in choosing as teachers individuals who can measure up to the very best in this respect, in order that they may offset such influences and really interest our boys and girls in the things most worthwhile. In the next place, our teachers should be those who appeal to high-school pupils. Certainly this does not mean that we want the popular type. Rather does it mean that our teachers should be able to attract and interest our young people, yet at the same time command their highest respect. In the next place, our teachers should enjoy thoroughly high-school young people. They ought to welcome rather than shun opportunities to be with them, to work with them, and to play with them. No individual who does not have this attitude should be serving as an instructor of our boys and girls. Lastly, although this, of course, does not exhaust the list, we want individuals who are willing and capable of giving individual attention. Only those who believe thoroughly that teaching is an individual rather than a group problem can qualify in this respect. To put it another way, we want teachers who are willing to go the second mile.

Other points discussed include the responsibility of the teacher-training institutions in eliminating undesirable candidates more effectively and the need of more honesty and frankness in making recommendations. Estimating the effect improvement along these lines would have upon supply and demand, the author concludes as follows:

In the first place, the effect will be wholesome for teachers as a whole. It will spur most of us to a higher degree of efficiency; it will awaken ideals which perhaps have been somewhat dormant. On the other hand, it will undoubtedly be unjust and unfair for some well-qualified individuals, many of whom will become discouraged and turn to other lines of work. Some of these the teaching profession can ill afford to lose. However, teaching as a profession will undoubtedly gain, considering the matter over a period of years. It is our responsibility to be patient and to uphold ideals meanwhile.

M. W. G.

ON SCIENTIFIC WRITING[1]

. . . .Scientific writing is of two main varieties: the first, writing by scientific men for the edification of those who are familiar with the ideas and language of the particular branch of science concerned; second, writing by scientific men for the uninitiated, whether they are comparatively learned people or comparatively ignorant people.

. . . .The degree of literary skill required for the two kinds of writing is perhaps not equal in the two cases. Suppose we consider the two cases separately—*first let us take the writing by chemists for chemists.* It seems to me that literary style hardly comes into the picture at all here; errors of grammar should obviously be avoided, if this is convenient, but otherwise the simpler and more accurate the statements are, the easier they will be to follow. The language of chemistry is as full of conventions as the language of bridge; if I double a no-trump I have no expectation of winning or losing twice the stake, I merely hope that my partner will say something. If a chemist says that a crystal of lithium chloride is composed of ions of lithium and chlorine he does not mean that there are many electrons out of their proper places; he merely means that the crystal is not an aggregate of separate molecules each consisting of one atom of lithium and one atom of chlorine. The convention is understood by those who play the game, and the rest of humanity may conveniently be ignored. . . . . The chemists know all these conventions; I sometimes doubt whether they realize that the rest of the world does not know that some of the phrases used by the chemist denote facts, and that others denote fictions. Easy as it is for the chemist to distinguish between these kinds of phrase, it is by no means easy for others, and I think some indulgence should be granted to editors who, devoting their lives to their own art, mystery or craft, have no time left for adding to their limited knowledge of the English language an esoteric knowledge of terms which connect the firm land of science with the quicksand of metaphysics. I include in such terms all those which denote phenomena that we do not understand, and merely name. . . .

[1] Excerpts from an article by Stephen Miall, Editor, *Chem. & Ind.*, **47**, 114–5 (Oct. 26, 1928).

Now we come to the literary skill desirable in writing of science by scientific men for the uninitiated. I refuse to consider the writing of science by men who are wholly ignorant of the science. . . . However literary a journalist may be, it is necessary to understand a subject before you can explain it. . . . . When you have an audience or a body of readers of a defined standard you must conform to that standard. . . . . How is one to write for a body of readers with such different tastes and standards? I think there are a few rules that we may all observe. First of all, writing is done to please the writer, not the reader; if there is some archaic phraseology or spelling that pleases us, shove it in. If our favorite author is Milton or Meredith, let us draw out with our pipet enough to make a lasting impression. The limits to these observances are that the printer—for which may he have our eternal blessing—usually disregards the faddist's spelling, and the editor, finding the article is five lines too long, looks first for a quotation as a possible source of space. . . . . I think it a good plan to write as simply as possible, using English words in preference to Latin and Greek, and adhering, usually, to the old-fashioned rules that a singular noun should agree with a singular adjective and even with a singular verb. There are articles I come across, and very likely write, that any competent judge would at once say were written by some one who was not accustomed to reading literature; there are other articles that give an impression, true or false, that the writer has at odd times read passages written by people who knew how to write. It is not easy for us all to attain to this degree of excellence, but I think any scientific man who wishes to write for the public at large should do so in such a manner that it is not obvious he is unaccustomed to reading the works of good writers. This is not a very high standard to expect, but it is a standard not invariably attained by professional writers. If those who are accustomed to good literature are to be designated as literate we cannot all reach this standard, but we need not sink so low as to be obviously illiterate. . . . . The chemist who reads his Addison, Defoe, Lamb, Macaulay, Thackeray, or Stevenson need have no fears; the chemist who founds his style on the average newspaper is on no sure foundation; the chemist who founds his style on that of the first chemist he comes across is in a very peculiar situation; some people are born lucky. . . . .

The standard we should aim at is the standard used by modern writers of good prose. . . . . If I were ever called upon to advise a young writer, I should recommend him or her to read some of the masterpieces of English literature. The technologist has often no time to spare for such reading; he is a producer of goods and not words; in that case he will not write easily or pleasantly. I have no reason to think that chemists have a lower literary standard than the members of several other professions, but it is a fact that there are very few well-written popular books on chemical subjects. . . . .

Chemists are so important a factor in modern civilization that it seems desirable that the general public should know more of what they are doing; indeed, their achievements are such that they would make a fascinating story for the general public to read, if only a few chemists had the time to tend the inclination to describe these achievements in terms that the general public could easily understand.

PRINCIPLES OF PROFESSIONAL CONDUCT

American Institute of Chemists

The profession of chemistry has become an increasingly important factor in the progress of civilization and in the welfare of the community. Chemists are entitled to the position and authority which will enable them properly to discharge their responsibilities and render effective service to humanity. In order that the honor and dignity of the profession be advanced and maintained, the American Institute of Chemists has prepared the following code to define the rules of professional conduct and ethics, binding on its members.

1. Every individual on entering the profession of chemistry and thereby becoming entitled to full professional fellowship, incurs an obligation to advance the science and art of chemistry, to guard and uphold its high standard of honor, and to conform to the principles of professional conduct.

2. It is the duty of a chemist to bear his part in sustaining the laws, institutions, and burdens of his community.

3. The chemist shall not knowingly engage in illegal work or coöperate with those who are so engaged.

4. A chemist shall carry on his professional work and act in a strict spirit of fairness to employers, contractors and clients, and in a spirit of personal helpfulness and fraternity toward other members of the chemical profession.

5. He shall refrain from associating with or allowing the use of his name by any enterprise of questionable character.

6. He shall advertise only in a dignified manner, being careful to avoid misleading statements.

7. He shall coöperate in upbuilding the profession by exchanging general information and experience with his fellow chemists and by contributing to the work of technical societies and the technical press, where such information does not conflict with the interests of his client or employer. It is very desirable that the first publication regarding inventions or other scientific advances be made through the technical societies and technical publications and not through the public press. Care shall be taken that credit for technical work be attributed as far as possible to the real authors of the work.

8. If, in his opinion, work requested of him by clients or employers seems to present improbability of successful results, he shall so advise before undertaking the work.

9. He shall be conservative in all estimates, reports, testimony, etc., and especially so if these are in connection with the promotion of a business enterprise.

10. He shall not accept compensation, financial or otherwise, from more than one interested party without the consent of all parties concerned and shall not accept commissions from outside parties and sales to his client or employer without their knowl-

edge. He is, however, in no way debarred from accepting employment from more than one employer where there is no conflict of interests.

11. He shall not use any unfair, improper or questionable methods of securing professional work or advancement and shall decline to pay or to accept commission for securing such work.

12. He may use all honorable means in competition to secure professional employment but shall not, by unfair means, injure directly or indirectly, the professional reputation, prospects or business of a fellow chemist and shall not attempt to supplant a fellow chemist after definite steps have been taken toward the latter's employment.

13. He shall not knowingly accept employment by a client or employer while the claim for compensation or damage, or both, of a fellow chemist previously employed by the same client or employer and whose employment has been terminated, remains unsatisfied, or until such claim has been referred to arbitration or issue has been joined at law, or unless the chemist previously employed has neglected to press his claim legally.

14. He shall be diligent in exposing and opposing such errors and frauds as his special knowledge enables him to recognize.

15. Any infractions of these principles of professional conduct coming to his attention shall be reported to the Ethics Committee of the American Institute of Chemists.

16. He shall not attempt to compete with a fellow chemist on the basis of professional charges, by reducing his usual charges in order to underbid after being informed of the charges named by the competitor.

17. He shall not accept any engagement to review the professional work (except journal articles and similar scientific publications and in litigation) of a fellow chemist without the knowledge of such chemist or unless the connection of such chemist with the work has been terminated.

18. When undertaking work for a client or employer, he should enter into an agreement regarding the ownership of any and all data, plans, improvements, patents, designs or other records which he may develop or discover while in the employ of such a client or employer. In the absence of a written understanding the following principles are held to apply:

(*a*) If a chemist uses information obtainable only from his client or employer which is not common knowledge or public property, any results in the form of designs, plans, inventions, processes, etc., shall be regarded as the property of the employer.

(*b*) If a chemist uses his own knowledge or information or data which by prior publication or otherwise are public property, then the results in the form of designs, plans, inventions, processes, etc., remain the property of the chemist and the client or employer is entitled to their use only in the case for which the chemist was retained.

(*c*) All work and results accomplished by the chemist outside of the field for which he was employed or retained are the property of the chemist.

(*d*) Special data or information obtained by a chemist from his client or employer or which he creates as a result of such information, are to be considered, and while it is ethical to use such data or information in his practice as forming part of his professional experience, its publication without permission is improper.

19. He shall as far as possible in consulting work fix fees at a point high enough to warrant complete and adequate service. Unreasonably low charges for professional work tend toward inferior and unreliable work. In fixing fees it is proper for him to consider:

(*a*) The time and labor involved, the novelty and difficulty of the matter and the experience and skill necessary.

(*b*) Whether the employment precludes other employment in similar lines or will involve the loss of other business while engaging in the particular work.

(*c*) Customary charges of chemists for similar services.

(*d*) The magnitude of the matter involved and the benefits resulting to the client from the service.

(*e*) The character of the employment, whether casual or for an established and constant client.

20. While it is desirable that chemists engaged in teaching and research should be permitted to use their special knowledge and skill in direct service to individual clients, it is prejudicial to the welfare of the profession for such services to be rendered at rates which ignore the ordinary costs of equipment, supplies, and overhead expenses.

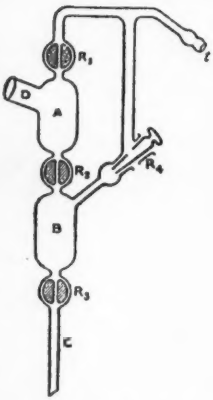
21. Having established a fair fee and billed same to a client, he should oppose any effort of a client to have such fee reduced without real and sufficient cause. Wherever compatible with self-respect and the right to receive a reasonable recompense for services rendered, controversies with clients regarding compensation are to be avoided. There should, however, be no hesitation to apply to the courts for redress to prevent injustice, imposition, or fraud.

Plans for Faraday Centenary. In response to the invitation of the Royal Institution, representatives of many scientific and technical societies met in the famous lecture theatre in Albemarle Street on Feb. 5th, to consider the preliminary arrangements for the celebration of the centenary of Faraday's great discovery of electromagnetic induction, which he made on Aug. 28, 1831. Sir Arthur Keith was in the chair, and in opening the proceedings reminded those present that the Royal Institution was not only the scene of Faraday's labors, but it was also for more than half a century his home. Sir William Bragg, director of the Royal Institution, said that the proposed celebrations had been in mind a long time, and in choosing the particular discovery of August, 1831, they were recalling one of Faraday's most important discoveries, on which rested a vast body of scientific and industrial development. The occasion would give the nation an opportunity of realizing the contributions to science and industry during the last hundred years. It was unlikely there would be another occasion so favorable, and if made a success, the centenary would encourage the people to go on with their work and brighten the whole outlook of the nation.

Among the speakers was Sir Ernest Rutherford, who not only approved the suggestions but also pointed out that in 1931 occurs the centenary of the birth of James Clerk Maxwell, who in a sense was Faraday's interpreter and put into mathematical form the latter's views. Col. K. Edgcumbe, president of the Institution of Electrical Engineers, Sir John Snell, Sir William Pope, Mr. D. N. Dunlop, Sir John Reith, Col. W. A. Vignoles, and Prof. J. L. Myres all promised the coöperation of the societies they represented. Prof. Myres made the interesting announcement that the officers of the British Association were prepared to recommend to their Council that the centenary meetings of the Association of 1931 should be held in London, and said they would be glad to do everything in their power to ensure that not only the intellectual descendants of Faraday himself, but also the large public interests which benefited from the applications of those discoveries, should be represented. The meeting approved the appointment of two small committees to deal with the scientific and industrial sides of the celebration, which Sir William Bragg announced would probably take place in the third week of September, 1931.—*Nature* (London), **123,** 251 (Feb. 16, 1929).

ABSTRACTS

TEACHING METHODS, AIDS, APPARATUS, AND SUGGESTIONS



A and *B*—bulbs of about 60 cc. capacity

C—outlet for fractions collected

D—tube (25 mm. dia.) to which side tube of distilling flask is connected

R_1, R_2, R_3—stopcocks separating bulbs

R_4—stopcock which permits entrance of air

t—tube which connects with vacuum pump

Separator for Continuous Fractional Distillation under Reduced Pressure. R. DELABY AND R. CHARONNAT. *Bull. Soc. Chim.*, **43–4**, 1287–8 (Nov., 1928).—To operate, the apparatus is connected to a vacuum pump through *t*, stopcocks R_1 and R_2 being opened and R_3 and R_4 being closed. The first fraction collects in *A* and runs into *B*. R_2 is then closed, R_4 opened to admit air, and R_3 then opened so that the fraction may run through *C* into a convenient flask. During this operation a second fraction is collecting in *A*. R_3 is then closed, followed by R_1, and a vacuum is reformed in *B*, after R_4 is turned to its original position. As soon as the vacuum is obtained, R_1 is again opened and the running off of fraction in *A* is accomplished as previously explained.

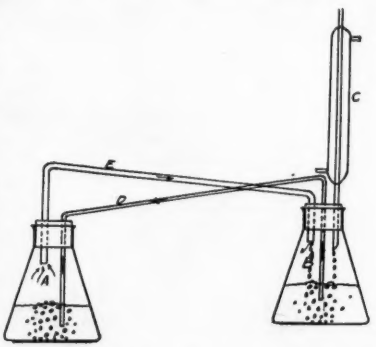
If only three fractions are to be separated, a flask is attached to *C* by a good rubber stopper. The distillation is begun with R_1, R_2, and R_3 open and R_4 closed. After the first fraction is collected, R_3 is closed, and the second fraction collects in *B*. R_2 is then closed and the third fraction is isolated in *A*.

This separator is made of pyrex and is quite compact (36 cm. high, 19 cm. wide). M. W. G.

An Extraction Apparatus. V. C. SHIPPEE. *Chem.-Analyst*, No. **46**, 12 (1925).—"The chief virtues of the extraction apparatus described below are simplicity and flexibility. It may be set up in 30 minutes' time, and can be constructed from simple apparatus which may be found in any laboratory. It can be adapted to large scale extraction if necessary, and can be made absolutely continuous in action.

"The apparatus necessary for this extraction apparatus consists of two wide-mouthed flasks, a Liebig condenser, some source of heat, rubber tubing, and glass tubing of different sizes, and in some cases a pinch clamp or screw clamp.

"Flask *A* is fitted with a two-holed stopper, or if continuous operation is desired, with a three-holed stopper. Through one hole passes a large piece of glass tubing *E*, slanting downward to flask *B*. Through the other hole passes a small piece of glass tubing, *D*, slanting downward to flask *A*. For continuous operation, a siphon *G* (not shown in drawing) may be added.



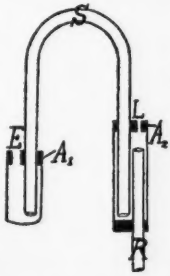
"Flask *B* is fitted with a three-holed stopper, through which pass the tubes *D* and *E* as mentioned above. Through the third hole passes the stem of a vertical condenser *C*. If a solvent of low boiling point is being used, the drain and faucet connections of the condenser may be reversed, thus making the apparatus a trifle easier to set up.

"The material to be extracted is placed in flask *B*, preferably in a bag, although it may be placed loose if desired. Flasks *A* and *B* are both filled one-third to one-half full with the solvent used. Heat is applied to each flask, greater heat being applied to *A*. The solvent will distil over from flask *A* into flask *B*. If the expansion of the solvent does not cause siphon

tube *D* to fill, and it usually does not, it will be necessary to start the siphon by blowing down the condenser tube at some time after distillation from flask *A* has commenced. This will cause used solvent to siphon from flask *B* to flask *A*, whence it will be returned to flask *B* by distillation through tube *E*. Condenser *C* serves effectively to discourage distillation from flask *B* to flask *A*.

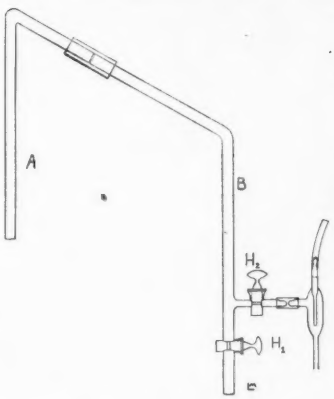
"If an especially lengthy extraction is to be made, old solvent may be drawn off through a siphon *G*, and new solvent poured in through condenser *C*. If siphon *D* shows a nasty disposition to empty itself completely, a trap *F* may be inserted in it." M. W. G.

A Practical Siphon. H. WENTZEL. *Chem.-Ztg.*, **52,** 898 (Nov. 17, 1928).—The siphon described and illustrated is particularly suitable when the rate of flow of liquid is to be controlled (as in cooling vessels). The apparatus consists of a U-tube *S* with equal arms, the ends of which are held in wider tubes by the stoppers A_1 and A_2. One of these tubes is closed at the bottom and the other contains the outlet tube *R*. The stoppers A_1 and A_2 have each another opening; in A_1, *E* serves as the liquid-inlet, and in A_2, *L* serves as an air-inlet. As soon as the level of the liquid falls below *E*, air enters *L* and emptying of the siphon is prevented. The siphon will therefore operate at all times.



C. E. M.

An Inexpensive Universal Siphon. G. BEETZ. *Chem.-Ztg.*, **52,** 868 (Nov. 17, 1928).—To operate the siphon: with H_2 opened and H_1 closed, blow by mouth a little air into pump, until the column of liquid is somewhat above H_2. Close H_2 and open H_1 to permit the liquid to run off. After closing H_2, the pump may be removed and used for other siphons. When the exit tube is full of the liquid up to H_1, further blowing and pumping is not necessary even if, by closing H_1, the process of emptying the vessel is interrupted. The siphon may be used for transferring liquids from a large vessel to several small ones by simply opening and closing the stopcock.

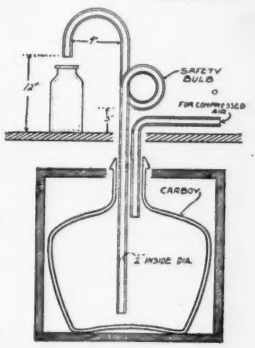


A —inlet tube
B —outlet tube
H_2 —stopcock, to which an injector pump is attached
H_1 —stopcock, through which liquid is run off

The advantages claimed are: (1) neatness of method, (2) constant readiness for use, (3) independence of pressure or suction and of addition of water, (4) complete removal of danger from person and material, (5) one pump used for as many siphons as desired, (6) even liquids of very high specific gravity may be easily drawn up, (7) easy replacement of each part, (8) low price.

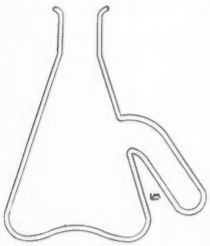
C. E. M.

Concealed Corrosive Liquid Siphon Apparatus. E. G. JARVIS. *Chem.-Analyst*, No. **46,** 13 (1925).—"The accompanying sketch illustrates an apparatus for siphoning acids and ammonia from carboys. The larger thistle tubes are made of ½-in. glass, and are inserted into a rubber stopper placed in the neck of the carboy. Air pressure is used for elevating the liquid. This apparatus has been found a convenient way of handling acids, etc." M. W. G.



Titration Flask for Avoiding Over-Stepping of End-Point. J. LINDER. *Chem.-Ztg.*, **52,** 868 (Nov. 17, 1928). —The titration flask recommended is shown in the accompanying sketch. A part of the solution being titrated may be easily withdrawn into the side-tube and

just as easily returned to the flask without losing any of the sample, whereas the flask is just as easily handled as an Erlenmeyer.

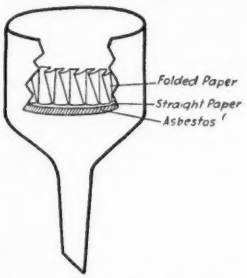


This flask may also conveniently serve as an absorption and titration vessel for the volumetric determination of carbonic acid in the elementary analysis of organic compounds, and in carbonate analyses. The advantage lies in the fact that the barium hydroxide solution, which is added to the contents of the flask after absorption, may be kept in the side-tube and added at the proper moment.

This sort of a titration flask should be of great value to those who are not especially experienced in titrating since it avoids overstepping the end-point, especially in test-titers where the composition is known to the analyst only within very wide limits. C. E. M.

A Rapid Filter for Quantitative Filtrations. N. S. SERINIS. *Chem.-Analyst*, **17**, 17–8 (Oct. 1, 1928).—"A Buchner funnel is prepared in much the same manner as the Gooch Crucible, *i. e.*, by pouring in the funnel macerated asbestos, with the suction turned on, until a heavy film of asbestos is formed at the bottom of the funnel. Then placing a filter paper to cover the asbestos it is washed thoroughly with hot water until all the loose particles of asbestos are washed away. When the wash water comes through perfectly clear the washing is complete. This filter can be used in three ways as follows:

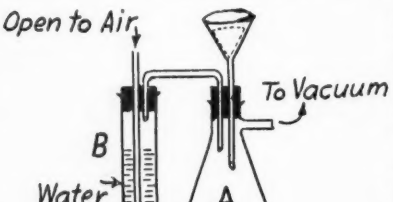
(*1*) *The bare asbestos*—used for filtration of substances that will destroy the filter paper and for precipitates that can be removed from the funnel by dissolving. In using the filter with bare asbestos one should be careful, while pouring the liquid in the funnel, not to disturb the asbestos. A small piece of glass placed somewhere in the funnel, and the liquid to be filtered poured gently on the glass, will greatly help keep the asbestos intact.



(*2*) *Asbestos with a straight filter paper*—used for the filtration of soluble precipitates. Advantages of this filter over the ordinary method are: faster than a Buchner; vacuum cannot be made high enough to cause any breakage of the filter paper; fine precipitates are filtered clear with perfect ease and the greatest speed.

(*3*) *Asbestos with a folded filter paper*—used for the filtration of insoluble precipitates which, of necessity, must be removed in some other way than by dissolving. Therefore the filter paper is folded to fit the Buchner and after the filtration the total precipitate is removed by removing the paper.

"Precipitates like $BaSO_4$ should not be filtered through this filter because small quantities of the precipitate will pass through the pores of the paper and in time will clog the asbestos film underneath and also in case the precipitate is to be recovered quantitatively erroneous results will be obtained. Combination of (No. 2) and (No. 3) will make a better filter, for $BaSO_4$, than (No. 3) alone but even that we would not recommend for accurate quantitative work.

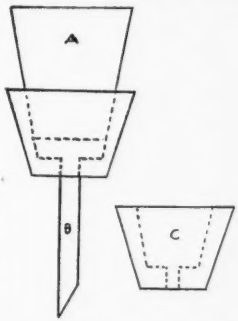


"The smallest size Buchner (55 mm. diam.) was found best suited for ordinary work but the writer had occasion to use Buchner funnel 125 mm. diam. with perfect satisfaction." M. W. G.

Suction as a Filtering Aid. G. L. HOCKENYOS. *Chem.-Analyst*, **17**, 18 (Oct. 1, 1928).—"It is often desirable to hasten the rate of filtration through a paper filter by applying a gentle suction. This must be continuous but not strong enough to break the paper. One good method often used is to siphon water from one large bottle to a second at a lower level. This has the disadvantage of being rather bothersome to set up and the following method is offered as a convenient substitute.

"An ordinary filter flask—*A*—is set up in the usual manner except that the valve—*B*—is attached to prevent the vacuum from attaining too high a value. This trap consists of an ordinary test tube with a glass tube open to the air at one end and extending to the bottom of the test tube. Water is now placed in the test tube to any desired height. The degree of vacuum depends on the height of the water in the test tube and four inches is ample for most purposes.

"A simple experiment showed that whereas it required ninety seconds to filter through an eleven-centimeter filter paper full of water, the same amount was drawn through in thirty seconds by this method. With gelatinous precipitates the saving of time is even greater." M. W. G.

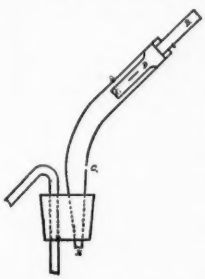


Gooch Tube Reinforcement. H. L. SIEVER. *Chem.-Analyst*, No. **46**, 12–3 (1925).—"The accompanying sketch illustrates an arrangement for replacing a Gooch filter tube, which tubes are continually breaking especially where a strong suction is used.

"It consists of a No. 7 rubber stopper (C) reamed out to fit a Gooch crucible, a stem of an ordinary filtering funnel (B) inserted in the cork. Bore a $^{7}/_{8}$" hole halfway through the stopper, then use a smaller bore for the glass stem or tubing.

"For an exact fit, the larger hole may be reamed out with a file or may be burned out with an old crucible. This will be found very convenient for filtering liquids that will not affect the rubber." M. W. G.

Exterior Bunsen Valve Wash Bottle. G. R. MICHENER. *Chem.-Analyst*, No. **46**, 13 (1925).—"The accompanying figure represents a wash-bottle mouthpiece. If carefully made it requires no attention excepting after standing without use for a long time, the valve is apt to stick, but a strong force of air will make it ready for use. This is a particularly convenient guard for ammonia and hot solutions of more or less volatile acids.

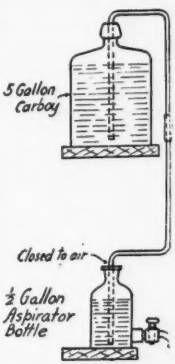


"Select a rather large glass tube and after softening it with heat at the desired length draw to a point: break at the narrow part and close by fusing. Place the tube directly over the center of the flame at the point *C* where it reaches its normal size and when the glass has softened blow into the open end. The result will be a glass bubble that will burst leaving a film of glass surrounding a hole at the point marked *C*. This glass film should be melted down until it is even with the outside of the tube leaving a smooth opening. With a little practice an aperture of the proper size can be formed. Bend just above the hole to an angle of about forty-five degrees and break open the closed end marked *X*.

"Take a short tube *B* that will fit loosely inside of the larger one and slip a rubber valve over this and insert it in the larger tube. The rubber should form an air-tight joint between the two tubes.

"The valve is the ordinary rubber valve made by closing with a piece of glass rod or small rubber stopper *S* one end of a short rubber hose longitudinally slit. The rubber stopper is preferable and can be formed the proper size with the cork borer. Insert this mouthpiece in the wash-bottle stopper; close the hole with the thumb and blow into it and if all the connections are tight, there will be a continuous flow from the delivery tube which can be checked instantly by releasing the thumb.

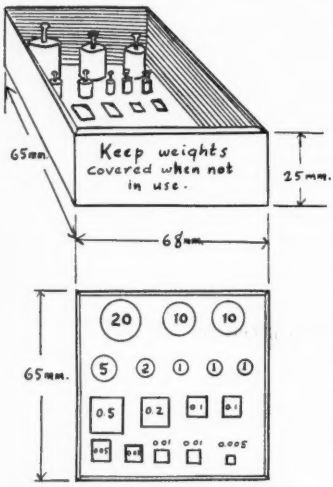
"A satisfactory method of forming nozzles on delivery tubes is to hold the end over the flame until nearly closed. The size of the opening is under control and it is more durable than when formed by drawing out to a point." M. W. G.



Distilled Water Container. C. H. PRITHAN. *Chem.-Analyst*, No. **44**, 24 (1925).—"The sketch represents a device for the delivery of distilled water. This idea eliminates all of the usual rubber tubes and glass siphons with the very unsatisfactory

tube clamps, stopcocks, etc. Also gives pure water as the operator only touches the glass top when turning it open. Any convenient size of glass tubing can be used and of course larger bottles. The distance between the shelves is best at some 20 inches as shown. Aspirator bottle should not be full but should be as indicated. If full it is impossible to keep the stopper in." M. W. G.

Keeping Analytical Weights in the Balance Case. C. J. SCHOLLENBERGER. *Chem.-Analyst*, **17**, 16 (Oct. 1, 1928).—An excellent substitute for the usual wooden block in which analytical weights are kept is easily made as follows: "Procure two pieces of window glass of suitable size, also some stiff white cardboard. Cut a piece of the latter to the same size as the glass and draw on this outlines of the base of each weight, plainly marking each with the denomination of the weight. The 20 and two 10-g. weights in one row, the 5, 2, and three 1-g. weights in the horizontal row below, and the decigram and centigram fractionals in two rows below in corresponding order, and the 5-mg. weight near the lower right corner. Place one piece of glass on this and bind the edges neatly with narrow strips of gummed paper. Cut strips from the cardboard slightly longer than the total of the four sides of the remaining glass plate, one slightly wider than the height of the tallest weight, the other as much wider than the first as the glass is thick. Glue these together with edges even at one side and before the glue has set bend into a frame so that the glass will fit into the recess formed by the outer layer of cardboard and will be supported by the inner layer. The ends of the double cardboard strip should be cut to the proper length but in such a way that the joints will be slightly offset when glued together. This cover may be further strengthened and made more neat by a covering of glazed paper, slightly overlapping the edges of the glass at the top.



"Weights kept in the balance case on a glass plate and covered when not in use as described, are practically as well protected as they would be in a wooden box, and are much more accessible and convenient to use. As they are not removed from the balance case, the chance of damage by a fall is reduced. The mechanical damage to the necks of the weights is lessened also, as one does not grip them so tightly with the forceps when lifting from the glass plate as would be necessary to lift from a hole in a block. The fractional weights are less likely to be bent in lifting from the glass than in removing them from a recess in a block." M. W. G.

An Improved Method for Cleaning Platinum Ware. C. GOODRICH. *Chem.-Analyst*, **17**, 18 (Oct. 1, 1928).—"There has lately been discovered in this laboratory an elaboration of the well-known potassium bisulphate method for the cleaning of platinum ware which has become stained by ashing organic materials, particularly starch and sugar materials in which the carbon has become partially fused into the surface of the platinum.

"Many instructions describe the method of fusing potassium bisulfate in a stained platinum dish, but without exception they advocate pouring out the material while still in the liquid form. It is just at this point that the new method differs from the old. Instead of pouring the material out at this point, continue the heating over a Meeker burner, moving the crucible constantly about the flame with the tongs until the material is spread out as a dry solid over the entire surface of the dish and there is no further evolution of smoky vapors. Then merely rinse under the tap, and the platinum will be found to be clean and bright." M. W. G.

Detection of the Presence of Reducing Radicals in the Systematic Analysis for the Acids. L. J. CURTMAN AND W. W. PLECHNER. *Chem. News*, **138**, 50–1 (Jan. 25, 1929).—Of the twenty-two acids which are commonly considered, twelve possess reducing properties. The presence of the latter was detected by adding a dilute solution of $KMnO_4$ to the acidified solution of the unknown and noting whether or not the

former is bleached. Details of procedure and data on its sensitivity are included.
M. W. G.

The Indexing of Chemical Compounds. A Contribution to the Problem of Organization of the Literature. H. REUMUTH. *Z. angew. Chem.* **41,** 1264–7 (1928); *C. A.*, **23,** 743 (Feb. 20, 1929).—A special form of card index is described which, by means of a series of tabs, permits the subject matter to be classified in several ways at once. In applying the system to organic arsenicals the author arranges the compounds by empirical formulas, but the tops of the cards are also so trimmed that projecting tabs show whether the compound is aliphatic, isocyclic or heterocyclic, whether it is a derivative of AsH_3, an oxide, an arsenous acid, etc. The form of card used is here reproduced.

CHO.... As

Aliphatic
Isocyclic
Heterocyclic
Aromatic
Diverse
Mono
Poly
Arsine
Oxide
Hydroxide
Arsonic
Arsinic
Acids
Mono
Di
Poly
Halide
Oxyhalide
Cyanide
Mono
Di
Poly
Sulfide
Arsenious =
Arsenic =
Corrected
Physiological Action
Physiol.

Name

Structural Formula

Characteristics

Bibliography

Solubility	*Physical Properties*	*Literature*
Alcohol		
Ether	M. P. °	
Benzol		
Benzine	Decomp. °	
Glacial acetic		
Carbon tetrachloride		
Acetone	Color	
	B. P. °/ mm.	
	$D^{20°}$	

M. W. G.

The High-School Study of Chemistry. G. A. PERLEY. *N. E. A. C. T. Report,* **30,** 60–8 (Jan., 1929).—Chemistry is a fundamental science and every high-school graduate is meeting it in some form, hence every youngster should have some knowledge of chemistry. Chemistry without the details, chemistry from a cultural viewpoint is what the high-school chemistry course should develop.

We should begin our high-school chemistry in the senior year—earth's crust, atmosphere, water, metals, etc., should be the order. O. C.

KEEPING UP WITH CHEMISTRY

The Production of Gaseous, Liquid, and Solid Hydrocarbons from Methane. Part 1. The Thermal Decomposition of Methane. H. M. STANLEY AND A. W. NASH. *Chem. & Ind.*, **48,** 1T–8T (Jan. 11, 1929).—The fact that the daily waste of high pressure natural gas in the Persian oil fields has been estimated to exceed 30,000,000 cu. ft., is an indication of the need for research on the utilization of the gaseous paraffins. This article presents an outline of the work which has been and is being carried out in the laboratories in the Dept. of Oil Engineering and Refining at the University of Birmingham. The conditions favorable to the production of higher hydrocarbons are discussed. E. R. W.

America Controls World Supply of Helium. C. MORAN. *Compressed Air Mag.*, **34,**

2677–8 (Feb., 1929).—"Sixty years ago a group of scientists who were observing an eclipse of the sun in India detected a bright yellow line which was destined at a later day to revolutionize air navigation."

"A helium-production plant now being completed near Amarillo, Texas, will furnish helium for many years to come, and give the United States Government a practical monopoly of the world's supply of this noninflammable gas essential for the safety of dirigibles."

Before the World War the cost of helium production was about $2000 per cu. ft. Through the research work of the Bureau of Mines the cost has been reduced to 3 cents per cu. ft. E. R. W.

Electrical Insulating Materials from a Chemical Standpoint. W. H. NUTTALL. *Chem. & Ind.*, **47**, 1359–68 (Dec. 28, 1928).—Investigators of electrical insulating problems should be trained in physical, colloidal and organic chemistry as well as in electricity. Most of the research work so far has been of the "hit or miss" variety. Carefully planned research work is needed in this field. Methods of comparing insulators are outlined, and some of the relations already found between constitution and dielectric constants are given. E. R. W.

Pharmacy in Europe and the United States. J. W. ENGLAND. *Am. J. Pharm.*, **101**, 82–105 (Feb., 1929).—A study of the conditions of the practice of pharmacy and pharmaceutical education in the following countries: Norway, Sweden, Italy, Monaco, Germany, Belgium, Holland, France, Great Britain, and a comparison with American conditions. M. W. G.

The Romance of Beverages. C. H. LA WALL. *Am. J. Pharm.*, **101**, 106–37 (Feb., 1929).—One of a series of popular science lectures presented by members of the faculty of the Phil. Coll. Pharm. & Sci., 1929 season. Historical and entertaining. M. W. G.

Gold Leaf—Old and New. I. GRIFFITH. *Am. J. Pharm.*, **101**, 157–61 (Feb., 1929). (Reprinted from *Bull.*, Wagner Free Inst. Sci., **3**, 59 (1928).)—A survey of the processes involved in manufacturing gold leaf. M. W. G.

That Poisonous Green Gas (Chlorine). ANON. *Chem. Warfare*, **15**, 494–9 (Jan. 15, 1929).—A discussion of chlorine, its preparation and its uses, written in a popular manner. Mention is made of its use in war gases, as a bleaching agent, in the manufacture of "chloride of lime" and in the purification of water. A brief comparison of chlorine and the other members of the halogen family is included. E. R. W.

The Reactivities of Solid Carbon in Fuel Processes. J. W. COBB. *Chem. Age*, **20**, 76–7 (Jan. 26, 1929).—A review of a lecture delivered by Professor Cobb in which the following topics are discussed; factors determining the reactivity of carbon, effect of inorganic substances, ignitibility, and water gas process. E. R. W.

Basic Industrial Minerals. I. Mica. G. M. DYSON. *Chem. Age* (*China Clay Trade Rev.*), **19**, 6–7 (Oct. 20, 1928).—An outline of the fundamental classes of micas, the production, properties and uses of mica, and the utilization of ground and synthetic mica for various purposes. M. W. G.

Basic Industrial Minerals. II. Barytes. G. M. DYSON. *Chem. Age* (*China Clay Trade Rev.*), **19**, 6–7 (Nov. 17, 1928).—The distribution of "heavy spar," the chief source of barium found in nature, and the properties and uses of barytes are discussed. M. W. G.

Basic Industrial Minerals. III. Graphite. G. M. DYSON. *Chem. Age* (*China Clay Trade Rev.*), **20**, 6–7 (Jan. 19, 1929).—An outline of the occurrence and methods of extracting graphite, its properties and uses. E. R. W.

The Heavy Chemical and Allied Industries in 1928. R. FURNESS. *Chem. & Ind.*, **48**, 6–8 (Jan. 4, 1929).—Among the industries discussed are those dealing with fixed nitrogen, artificial silk, soap and glycerol, beet sugar and economic utilization of coal. E. R. W.

The Chemical and Allied Industries. Part 2. The Acids, Alkalis, and Salts. R. FURNESS. *Chem. & Ind.*, **48**, 3–6 (Jan. 4, 1929).—A discussion, giving something of the history, more of the present conditions of the chemical industry in Great Britain. E. R. W.

The Story of the Chemical Elements. A. A. NOYES. *Science*, **69**, 19–26 (Jan. 11, 1929).—(Address delivered at the New York Meeting of the A. A. A. S. by its retiring president.) An account of the development of atomic and sub-atomic theory from the time of the appearance of the periodic system to the present. G. H. W.

The Structure of Atomic Nuclei. *Nature* (London), **123**, 246–8 (Feb. 16, 1929).—A report of the discussion on atomic nuclei held at the Royal Society meeting on Febru-

ary 7. The speakers, whose comments are recorded, included Rutherford, Chadwick, Fowler, Aston, and Richardson. M. W. G.

A Symposium on Atomic Structure and Valence. *Chem. Rev.*, **5** (Dec., 1928).—The papers included in this volume are:

1. Recent Progress in the Study of the Structure of the Nucleus. S. C. Lind.
2. The Synthesis of Atoms, the Whole Number Rule, and the Periodic System of the Atomic Species. W. D. Harkins.
3. Atomic Structure as Revealed by Crystal Reflection of X-Rays. G. E. M. Jauncey.
4. Dissociation of Molecules as Disclosed by Band-Spectra. K. K. Darrow.
5. The New Quantum Mechanics. J. H. van Vleck.
6. The Electron Theory of Valence. W. H. Rodebush.
7. Valence Forces as Calculated from Specific Heats and Absorption Spectra. D. H. Andrews.
8. The Relation of Shared Electrons to Potential and Absolute Polar Valences. W. A. Noyes.
9. A Pragmatic System of Notation for Electronic Valence Conceptions in Chemical Formulas. H. S. Fry.
10. The Theory of Partial Polarity of the Ethylene Bond and the Existence of Electro-Isomerism. M. S. Kharasch and F. R. Darkis.
11. The Broader Aspects of Valence: Its Application to Colloid Compounds. V. Cofman. M. W. G.

Recent Research on the Vitamin. K. H. COWARD. *Am. J. Pharm.*, **101**, 145–56 (Feb., 1929).—A survey of recent work accomplished relative to vitamin research, with bibliography. M. W. G.

Recent Advances in Science—Biochemistry. R. K. CANNAN. *Sci. Progr.*, **23**. 395–404 (Jan., 1929).—*The Physiological Action of Drugs.* A brief discussion is given of the work of A. J. Clark and his colleagues on the reversible activity of certain drugs.

Unsaturated Hydrocarbons in Animal Fats. The unsaponifiable fraction of cod liver oil contains squaline and related substances. When rats are fed upon this, there is an increase in the amount of unsaponifiable matter in the liver fats, part of this is due to an accumulation of squaline and part to an increase in amount of cholesterol. Squaline may be the precursor of cholesterol.

The Chemistry of the Tyrosinase Reaction. Raper has shown the probable structural changes involved in the conversion of tyrosine into melanin.

The Acid-Base Relations of Proteins. The reversible reactions of proteins with acids and bases are stochiometric and are in accord with electrolytic dissociation. Discussion is given of recent work establishing Loeb's arguments. A. E. C.

Recent Advances in Science—Physical Chemistry. R. K. SCHOFIELD. *Sci. Progr.*, **23**, 404–9 (Jan., 1929).—*Chemical Kinetics in Homogeneous Systems—Gaseous Reactions.* A discussion of recent researches which lead to the suggestion that for the type of reaction under consideration, unimolecular and bimolecular rates are to be expected at either end of a continuous range. The appearance of the former type is favored by complexity of molecular structure and high pressure, the latter by simplicity of structure and low pressures.

Acidic and Basic Catalysis. The new method of approach to the explanation of catalytic reactions, such as the hydrolysis of cane sugar, is due chiefly to Brönsted who recognizes that the net action that occurs to the substrate is either the acceptance or loss of a proton (H) or its tranference from one position in the molecule to another. In the presence of molecules which are ready acceptors of protons and of others that are ready donors the prototropic change is facilitated, and the reaction catalyzed.

Reactions between Ions. Experiments in which the primary reactions are between ions have been performed supporting Brönsted's theory that reaction velocity depends on the concentration of a critical complex in equilibrium with the reactants. A. E. C.

X-Ray Applications in Every-day Life. GEORGE L. CLARK. *Sci. Mo.*, **28**, 172–8 (Feb., 1919).—X-rays are in every way identical with ordinary light except that the wave-lengths are only about $^1/_{10,000}$ as great. Because x-rays are shorter than light it follows that they are more penetrating, that they should pass through materials opaque to light and that they should be associated with a finer subdivision of matter than is apparent by examination in visible radiation. While x-rays penetrate matter opaque to light, they are absorbed differentially because objects of different densitities have different absorbing power. The effect of this may be recorded on a photographic plate or observed on a fluorescent screen. Many of the varied uses, from that in

connection with the molecular structure of matter to the study of cancer in living tissue and the examination of steels for internal strain, etc., are enumerated.
G. W. S.

Casein and Its Industrial Applications. I and II. W. L. DAVIES. *Chem. Age*, **20**, 23–4 (Jan. 12, 1929); 43–4 (Jan. 19, 1929).—These articles contain a discussion of the chemistry of casein, methods of preparing and grading it, and its use in the manufacture of adhesives, paper, plastics, paints, etc. E. R. W.

Stains from the Laundry. EDITORIAL. *Silicate P's & Q's*, **9**, 1–2 (Feb., 1929).—Iron stains, for example, are very objectionable whatever may be their source. Any treatment which minimizes their appearance or the discoloration of a fabric from any other source is not only highly acceptable to the industrial laundry but to the home laundress as well.

Ordinary soap does not always prove a best reagent for a cleansing operation Most commercial laundries use mixtures of soap with builders (as they are known), some of these being alkali carbonates and silicate of soda. Careful tests have shown that the latter is especially successful in preventing iron stains and general discoloration in waters containing even as much as ten parts per million of dissolved or suspended iron. The silicate not only seems to prevent the stain upon the fabric but is known to prevent the dissolving of the iron pipe by the water or the formation of the rust upon it.
B. C. H.

HISTORICAL AND BIOGRAPHICAL

Arnold Sommerfeld on His 60th Birthday. *Chem.-Ztg.*, **52**, 941 (Dec. 5, 1928).—Brief account of contributions to science. M. W. G.

Joseph Black. *Chem.-Ztg.*, **52**, 913 (Nov. 24, 1928).—Biographical. M. W. G.

Carl Freiherr Auer von Welsbach. F. M. FELDHAUS. *Chem.-Ztg.*, **52**, 689 (Sept. 1, 1928).—Biographical with photograph. M. W. G.

Wilhelm Ostwald. W. HERZ. *Chem.-Ztg.*, **52**, 690 (Sept. 1, 1928).—Birthday tribute. M. W. G.

Frederick Mollwo Perkin. *J. Chem. Soc.*, 3299–3300 (Dec., 1928).—Obituary. F. M. Perkin, son of Sir Wm. Perkin, died May 24th, 1928. His technical work was concerned largely with the production of fuel oils from coal and from peat. "He worked on the carbonization of coal, and the production of smokeless fuels—he may be regarded as one of the pioneers of low-temperature carbonization." M. W. G.

Carl Graebe. P. DUDEN AND H. DECKER. *Ber.*, **61**, 9–46 (Feb. 8, 1929).—Biographical with 2 portraits. M. W. G.

Hendrick Antoon Lorentz (1853–1928). *Proc. Royal Soc.*, **121**, xx–xxviii (Dec., 1928).—Obituary with portrait. M. W. G.

Svante August Arrhenius (1859–1927). J. WALKER. *Proc. Roy. Soc.*, **119**, ix–xix (July, 1928).—Biographical with portrait. M. W. G.

Theodor Paul (1862–1928). R. DIETZEL. *Ber.*, **62**, 7–11 (Feb. 6, 1929).—Obituary with portrait. M. W. G.

Paul Heinrich V. Groth (1843–1927). H. STEINMETZ. *Ber.*, **61**, 65–8 (May 9, 1928).—Obituary with portrait. M. W. G.

The Birthday of Fritz Haber. H. GROSSMANN. *Chem.-Ztg.*, **52**, 953–4 (Dec. 8, 1928).—Biographical. M. W. G.

Eduard Donath—80th Year. A. LISSNER. *Chem.-Ztg.*, **52**, 941 (Dec. 5, 1928).—Biographical. M. W. G.

Marcelin Berthelot. L. ILOSVAY. *Természettud. Közlöny*, **60**, 49–57 (1928); *C. A.*, **23**, 742 (Feb. 20, 1929).—A memorial lecture delivered before the Hungarian Academy of Sciences, Nov. 28, 1927. M. W. G.

The Most Recent Investigations of the Antecedents of Alchemy. E. O. VON LIPPMANN. *Chem.-Ztg.*, **52**, 973–4 (1928). M. W. G.

Theodore William Richards, 1868–1928. *Proc. Roy. Soc.* (London), **121A**, xxix–xxxiv (1928).—Obituary. M. W. G.

Historical Comment upon the 100th Anniversary of Wöhler's Discovery. O. OHMANN. *Chem.-Ztg.*, **52**, 877–8 (Nov. 10, 1928). M. W. G.

The Nobel Prize Winners for Chemistry for 1927 and 1928. *Chem.-Ztg.*, **52**, 961–2 (Dec. 12, 1928).—The article is divided into two parts—Heinrich Wieland by H. Fischer and Adolf Windaus by F. Kögl—each of which contains a short account of the work for which the award was made. M. W. G.

Ammonium Chloride in the History of Alchemy. J. RUSKA. *Z. angew. Chem.*, **41**, 1321–4 (1928). M. W. G.

Some Bohemian Alchemists. J. G. F. DRUCE. *Pharm. J.*, **121**, 2 (1928); *C. A.*,

23, 8 (Jan. 10, 1929).—The following alchemists and their works are noted: Jan Smil of Pardubice (about 1400); John of Tetschen (early 15th century); John Černý ("Johannes Niger") 1480–1530; Bavor Rodovsky (born 1526); Jacob Dobrensky (born 1632); Christopher Bergner, 1721–93. M. W. G.

The Ninth International Conference of Chemistry. J. GÉRARD. *Chim. & Ind.*, **20,** 405–13 (Sept., 1928).—Reports of the various committees attending the international conference which met at the Hague, July 18–24, 1928. Pictures of groups of delegates included. M. W. G.

EDUCATIONAL MEASUREMENTS AND DATA

Impersonal Measurement of Teaching. F. A. MOSS, WM. LOMAN, AND THELMA HUNT. *Educ. Record*, **10,** 40–50 (Jan., 1929).—This is the resumé of an experiment carried out by the Association of Land Grant Colleges in twenty-eight of these colleges. The purpose of the experiment was to measure teaching efficiency, arbitrarily considered in this case as varying directly with desirable changes produced in students by teaching. The subject selected was beginning chemistry in college. At the beginning of the term two tests were given. One was a test of mental alertness to ascertain the ability of students to learn. The other was a standardized chemistry test to ascertain present chemical information of the students. This test was given again at the close of the term. The test had a reliability coefficient of 0.90 and a validity coefficient of 0.638, the latter being correlated with chemistry marks. The test was given to 6667 students. The median score was 63, with a Q of 18.8. The possible maximum score was 150. Students who had had one year of high-school chemistry made a median score 17 points higher than those who had not had high-school chemistry. The median score of the twenty-eight colleges tested ranged from 37.25 to 87. In some schools the lowest quartile was higher than the highest quartile in other schools. Colleges in the different sections of the country varied considerably as shown by the following median scores: North Atlantic 70; Far West 70; South 59; and Middle West 56. The influence of high-school chemistry and intelligence on the test scores were determined by computing the regression coefficient. The corrected medians indicated the relative efficiency of the different chemistry instructors. Types of departmental organization had a very noticeable effect on median scores, the large institutions with several lecturers have the highest median and large institutions with one lecturer having the lowest median. Class efficiency seems to decrease as the size of the class increases above 30 or 40. The degree of the instructor seems to have little effect on efficiency, those with Master's degree doing as well as those with Doctor's degree. The same is true regarding the instructor's rank, Professors ranking lowest. Teaching efficiency seems to decrease after eleven years' experience. A teaching load of 14 to 18 hours gave the highest median. This method seems to offer a very good means of measuring teaching efficiency impersonally. C. M. P.

Procedures and Results of Efforts to Reorganize Science Instruction in the University of Minnesota. E. M. FREEMAN. *Peabody J. Educ.*, **6,** 204–18 (Jan., 1929).—The investigation assumes that there are two types of students to be served by science instruction in colleges; (1) those for whom it assumes the rôle of vocational training, or the students who major in science, and (2) those "hordes of graduates whom we have a right to expect have an intelligent understanding of science and its relation to human affairs."

The suggestion is thrown out that science teachers may work their science content in a thoroughly scientific manner but that it does not necessarily follow they will attack their science teaching problems in a similar way. As an instance, it has not yet been established beyond question that the more expensive laboratory method of teaching can, by its results, justify its additional cost.

The committee, which initiated the work this paper is reporting, analyzed the field of science instruction in the University of Minnesota and formulated the following aspects of the general problem: *A.* The curriculum of science; *B.* Aims and objectives in instruction in science; *C.* Methods of instruction in science; *D.* Measurement of achievement in science; *E.* Costs of instruction in science.

Some studies already made or under way are: medical school investigation of dissection; optimum amount of laboratory work in medicine; worth of laboratory work to a certain vocational group of physics students; and a study of a prerequisite course in botany. B. C. H.

THE METHODS AND PHILOSOPHY OF EDUCATION

The Cost of Education. EDITORIAL. *Chem. Bull.*, **16,** 51 (Feb., 1929).—The writer gives his answer to the question, "Is education worth what it costs?" He

believes that a college education is necessary for a scientist but that the business man may get along without it, and leaves the question open regarding others. E. L. M.

A Prophetic Experiment. E. O. GROVER. *J. Natl. Educ. Assoc.*, **18,** 41–2 (Feb., 1929); [*cf.* Needed Changes in American Institutions of Higher Learning. THIS JOURNAL, **6,** 583 (Mar., 1929)].—The conference plan of instruction is used at Rollins College, Winter Park, Florida. The plan consists of substituting informal conference or discussions for the formal lecture; it also eliminates the final examination horror and encourages the student to quiz the professor instead of having the professor quiz the student. Some of the students feel they are getting an education in terms of adventure. A. E. C.

Higher Education in 1928. F. J. KELLY. *J. Natl. Educ. Assoc.*, **18,** 59 (Feb., 1929).—In higher education trends have been discernible in the following movements: (1) the increasing emphasis upon effective teaching by members of college faculties; (2) emphasis on studies of student personnel; (3) development of germs of independent study; (4) closer correlation between high school and college. A. E. C.

THE PHILOSOPHY OF SCIENCE

The Relation of Science to Industry. ROBERT A. MILLIKAN. *Science,* **69,** 27–31 (Jan. 11, 1929).—The debt of industry to pure science is of such magnitude that it may be said "Pure science begat modern industry."

Modern marvels such as the radio and airplane have behind them a background of two hundred years of work in pure science. The present application of great discoveries in pure science are of less importance than the discoveries themselves.

The advance of pure science has wrought a spiritual and intellectual revolution as well as a material one. G. H. W.

The Need of and Opportunity for Precise Analysis. S. POPOFF. *Chem. Bull.*, **16,** 43 (Feb., 1929).—The object of the article is to present and emphasize the need and opportunity of employing precise methods of analysis.

The writer states in effect that all chemical advances, whether synthetic or theoretical, eventually demand precise measurements since chemistry is an exact science; that all practice and theory must be supported by precise and unquestioned methods of analysis.

The following topics are discussed in developing this point of view: "Pure Chemicals," "Precise Measurements," "Interpretations," and "The Opportunities for Precise Analysis." E. L. M.

MISCELLANEOUS

American Association for the Advancement of Science. *Science,* **69** (Jan. 25 and Feb. 1, 1929).—These special issues of *Science* contain the general reports and the accounts of the various sessions of the Fifth New York Meeting of the A. A. A. S. held in December, 1928. The reports of the *Chemistry* and the *Education* Sections are herewith given.

Chemistry (By G. Dietrichson, pp. 112–13). The program of Section *C* was made up mainly of joint sessions with other groups. At the first of these, held with Section *N* on Thursday afternoon, six papers were presented on recent development in the chemistry of naturally occurring remedial agents. Professor Roger Adams gave his retiring vice-presidential address on "Synthetic Organic Acids as Substitutes for Chaulmoogra Oil." He reviewed extensive work by himself and his associates in attempting to find an effective remedy for leprosy. K. K. Chen presented the results of a study of ephedrine homologs and isomers with reference to the relationship between their pharmacological action and their chemical constitution and stereoisomerism. Charles E. Bills gave an extensive review of ergosterol chemistry, describing the methods used in attempts to produce vitamin D from ergosterol, with special attention to the use of the quartz spectrograph and the photoelectric cell. Oliver Kamm's paper on "Hormones from the Pituitary Gland" (abstracted in *Science* for January 25), which was awarded the annual American Association prize, was presented in this symposium. E. J. Cohn discussed the work that is being done toward isolating the active liver principle effective in the treatment of pernicious anemia. H. Jensen and John J. Abel gave a review of the chemistry of insulin, with special reference to the isolation and possible synthesis of the hormone which it contains.

On Friday forenoon Section *C* met with Section *K* (Social and Economic Sciences), the subject for discussion being "Economics and Chemical Progress." The chairman of Section *C*, Dr. C. E. K. Mees, called attention to the continual changes that are being made in chemical industries and to the economic problems involved. He was followed

by L. V. Redman who spoke about the cost of research and the ultimate possible returns in comparison with other forms of investment. The subject of research costs and accounting was presented by F. P. Byerly. In concluding the symposium, Charles H. Herty discussed cartels and combines in the chemical industries, expressing the idea that combinations are economically sound if they do not lead to monopoly.

Section *C* met jointly with Section *M* (Engineering) for a discussion of "The Chemistry of Metals." F. F. Lucas described high-power microscopic equipment developed in the Bell Telephone Laboratories for studying the structure of alloys, showing lantern slides of remarkably beautiful photographs and emphasizing the value of these in interpreting crystallization phenomena. In a paper on "Elastic Failure and Fatigue Failure of Metals," H. F. Moore pointed out the characteristics of these two effects and discussed the observed structural changes and the possible atomic relations involved. John Johnston emphasized the limitations of purely chemical specifications in the metal industry, saying that these should generally be supplemented by suitable physical and mechanical tests. The influence of surface films on corrosion was discussed by F. N. Speller, who pointed out that the formation of a suitable film seems to be the principal factor in preventing corrosion. E. H. Dix gave an interesting account of the composition and properties of various aluminum alloys that have proved useful in aircraft construction.

At the Saturday forenoon session Professor A. Frumkin, of the Karpow Institute of Chemistry in Moscow (visiting professor of colloid chemistry at the University of Wisconsin), gave a paper on "Hydrolytic Adsorption of Charcoal," showing that adsorption of acids by activated charcoal was directly dependent upon the presence of oxygen, whereas the presence of hydrogen had a corresponding influence on adsorption of alkalis. H. V. Arny outlined an extensive research problem undertaken by the American Pharmaceutical Association on the influence of light on medicinal chemicals. There was a well-attended luncheon meeting with the American Institute, with a series of talks on "Recent Advances in Synthetic Organic Chemistry." Roger Adams outlined many important developments in the field of synthetic medicinal chemicals. Charles H. Herty spoke of recent achievements in utilizing by-products, as in the lumber industry, and Edwin E. Slosson called attention, in his usual entertaining way, to some possibilities with respect to synthetic foods.

Education (By A. S. Barr, p. 130). Section *Q* held seven sessions at New York, one devoted to each of the following topics: the experimental study of elementary education, educational research in higher institutions, educational psychology, measurements and scientific technics, social aspects of education and research in public school systems, and one to the retiring vice-presidential addresses for Sections *I* and *Q*. About fifty papers were presented altogether. Among the speakers were Leonard, Gray, Toops, Gesell, Thurstone, Lincoln, McGaughy, Dearborn, Kelley, Thorndike, Courtis, Pechstein, Symonds, May, Wood, Coxe, Kallom, Connor, Witham, Boyer, Stenquist, Wallin, Dunlap and Gates. The papers were excellent in quality, the attendance was good and a great variety of topics were discussed. Sixteen papers dealt with experimental studies on teaching and learning, twelve dealt with measurements and scientific technic of various sorts, nine papers dealt with research in higher institutions, eight dealt with social aspects of education, six dealt with elementary education and two reported laboratory and case studies. Many of the papers will appear in *The Journal of Educational Research, The Journal of Educational Psychology* or in *School and Society*. M. W. G.

Explosion Risks with Volatile Solvents. The danger of explosions in such plants as that used for solvent recovery is one which can only be avoided completely by using vapor-air mixtures below the lower limit or above the upper limit of inflammability. G. Weissenberger and L. Piatti (*Z. angew. Chem.*, Nov. 24, **1928**) quote values for these limits for many common solvents, but, as they point out, the exact figure depends on such circumstances as the dimensions of the plant, and can be influenced by impurities in the solvent, so that a "factor of safety" is desirable. In many cases the mixture below the lower limit of inflammability is so weak that normal condensation of the solvent is impracticable, and some form of adsorption process must be used.—*Chem. & Ind.*, **48**, 148 (Feb. 8, 1929).

Local Activities and Opportunities

Through these columns, the JOURNAL desires to render a two-fold service.

1. **Local Activities.** Keeping its readers in touch with the varied interests of institutions, A. C. S. sections, teachers' asssociations, and other organizations throughout the country. Items of general interest would include: (1) notices of local scholarships or fellowships; (2) notices of any special gifts to chemical organizations or departments—as fellowships, endowments, laboratory gifts, library gifts, etc.; (3) accounts of meetings, social functions, exhibitions, chemical entertainments, etc., which might be suggestive to other organizations (where original or unusual features are included it is desirable that they be described in some detail); (4) news notes concerning persons of sufficient prominence in their respective fields to make their movements of general interest; (5) promotions within, or changes of, personnel of a department; (6) announcements of new or unusual courses in chemical education or special fields of chemistry; (7) notes on new chemistry buildings or laboratories, stressing the unique features.

2. **Opportunities.** Providing an exchange column for positions. That is: (1) any teacher who is a subscriber to the JOURNAL, desiring to change his position, may advertise once a year without charge (correspondence will be handled through the editorial office, if desired); (2) any notices of vacancies, in which chemistry teachers and chemists will be interested, will also be published.

The responsibility of reporting items for this section rests entirely with the local institutions and organizations. It would be desirable to have some person connected with each organization and institution appointed to report regularly.

Suitable material sent to the editorial office before the 20th of each month will be published in the following month's JOURNAL. The Editorial Staff must necessarily reserve the right to abridge or totally reject any items submitted. If the above suggestions are followed, however, the necessity for such action will be largely obviated.

University of Arizona. On February 26th, Dr. Robert A. Millikan, Director of the Norman Bridge Laboratory of Physics, California Institute of Technology, gave a public lecture at the University under the auspices of the Public Lectures Committee of the University. His topic was: "Available Energy." A capacity audience of 1500 attended the lecture, which was presented in a masterly manner and was well received.

On February 20th, Dr. D. T. MacDougal, Director of the Laboratory of Plant Physiology of the Carnegie Institution of Washington, lectured before the Arizona Chapter of Sigma Xi, on the subject: "Growth as Studied in Trees and Cacti by the Aid of the Dendrograph." The lecture was illustrated with slides and experiments.

The Committee on Prize Essays (Dr. Ernest Anderson, Chairman) is at present judging the essays submitted this year. Sixty-five essays were received, and ten high schools of the state are represented. Arizona has taken an active interest in the American Chemical Society Prize Essay Contest ever since its inception and three national prizes have been won by Arizona high-school pupils.

College of the City of New York. At meetings held by the Baskerville Chemical Society, addresses were delivered by Mr. A. Krugley on "Plastic Paints," and by Professor Harrow on "Histidine: An Essential Amino Acid."

Dr. Graham and Mr. Rudolf Babor, of the Ethyl Gas Corporation, gave a lecture and demonstration on anti-knock gasolines (lead tetraethyl) before the joint meeting of the chemical, mechanical, and electrical engineering students on March 7th.

Professors Babor and Estabrooke were granted a patent on the manufacture of special light insulating material superior to asbestos.

The following papers have been published recently by members of the staff:

"Detection of the Presence of Reducing Radicals in the Systematic Analysis for the Acids," L. J. Curtman and W. W. Plechner, *Chem. News*, **138,** 50 (1929).

"Precipitation of Group II Acids (the Chloride Group) in the Presence of Other Acid Radicals," L. J. Curtman and W. W. Plechner, *Chem. News*, **138,** 65 (1929).

"Titanium Offers New Possibilities as a Pigment," A. W. Hixson and W. W. Plechner, *Chem. & Met.* **36,** 76 (1929).

Dartmouth College. President Hopkins of Dartmouth has recently announced appointments to eight graduate fellowships for the next academic year. Among the eight seniors and recent graduates of Dartmouth to receive this honor are Henry W. Scherp, '28 of Dalton, Mass., and George W. Wheland, '28 of Chattanooga, Tenn., who are at present graduate students in chemistry at Harvard and who have already held their fellowships for one year.

During the present year three of the eight fellowship holders are working in the field of chemistry, the third being Tyrrell H. Werner, '25 of West Hartford, Conn., also a student at Harvard.

Columbia University. Dr. Harold C. Urey joined the staff in February as associate professor of chemistry. Before coming to Columbia he was associate in the chemistry department of Johns Hopkins University. Dr. Urey took his B.S. in 1917 at the University of Montana and the degree of Ph.D. was awarded him by the University of California in 1923. His research interests are in atomic and molecular structure, kinetics of reactions, and photochemistry.

Prof. Victor K. LaMer lectured at the Franklin Institute, Philadelphia, on March 7th, on "The Theory of Strong Electrolytes." He addressed the Maryland Section of the A. C. S. at Baltimore, on the same subject on March 22nd.

Prof. C. D. Carpenter spoke on "Keeping Up in Chemistry" at St. Stephen's College, March 4th.

Dr. Olive M. Lammert (Ph.D., Columbia) has been promoted to the rank of professor of chemistry at Vassar College.

Dr. Jessie Y. Cann (Ph.D., Columbia) has been elevated to the rank of professor of chemistry at Smith College.

Prof. A. W. Thomas gave an illustrated lecture on microstructure of skin and leather at the March 8th meeting of the New York Chemistry Teachers' Club.

Bucknell University Chemists Make Survey of Graduates' Work from 1913–1928. Coöperating with the Chemical Engineering Alumni Association of Bucknell University, an extensive survey has been conducted in order to determine the nature of the professions in which the graduates of the chemical engineering department are engaged. It was largely due to the numerous requests from various colleges and universities, contemplating the institution of a chemical engineering course, for such a directory that this analysis has been made.

This survey has been conducted by Dr. S. C. Ogburn, Jr., head of the chemical engineering department of Bucknell University, and some interesting facts have been obtained. The material for this study has been collected from university alumni records, and from personal communications, and gives an authentic record of all the men who have graduated from the department with a degree of B.S. in Ch.E., since the institution of the course, in 1913, until 1928.

The entire number of graduates during the interval named has been divided roughly into three divisions: (*a*) those having occupations in which their professional training predominates; (*b*) those having occupations in which their professional training does not predominate; and (*c*) those for whom no occupational record could be obtained. These divisions are further subdivided according to the specific type of occupation, and in each of these latter cases the percentage of the entire graduate body from the department in this field of endeavor was determined.

The following is a summary of the data obtained:

Occupations in which the professional training dominates.

(*a*) Chemical Engineers and Industrial Chemists	49.74%
(*b*) Research Chemists	6.38%
(*c*) Teachers of Chemistry	11.34%
(*d*) Chemical Salesmen	4.26%
(*e*) Chemical Lawyers	0.71%
Total	72.43%

Occupations in which the professional training does not predominate.

(*a*) Industrial work, non-chemical	4.88%
(*b*) Non-industrial, non-chemical	12.05%
Total	16.93%
(*c*) No occupational record available	10.64%

It should be noted that this data covers the period from 1913 to 1928 inclusive. A consideration of these facts presented will show that the greater majority of the graduates from the department are using their technical knowledge in their present occupation. Only 16.93% of the entire graduate body have abandoned the field of chemical endeavor and for 10.64% no occupational record could be obtained. Of these 10.64% it is quite probable that one-half of the number are actively engaged in professional chemical work. The outstanding fact shown was that out of approximately 150 graduates of the chemical engineering department, 72.43% of these are actively engaged in professional chemical work. First Degree, B.S. in Ch.E., was granted in 1913.

College of Mines, University of Washington and Northwest Experiment Station, United States Bureau of Mines, Seattle, Washington

RESEARCH FELLOWSHIPS IN COAL AND NON-METALLICS 1929–1930

The College of Mines of the University of Washington offers five fellowships for research in Coal and Non-Metallics in coöperative work with the United States Bureau of Mines. The value of each fellowship to the holder is $720, for 12 months beginning July 1st; fellowship holders pay tuition and laboratory fees, but are reimbursed for the amounts so expended.

The fellowships are open to graduates of universities and technical colleges who are qualified to undertake research investigation. Ordinarily the appointees register as graduate students, and if properly prepared, become candidates for the degree of master of science in mining or metallurgy or ceramics; otherwise they may register for a bachelor's degree in one of these curricula.

The purpose of these fellowships is to undertake the solution of various problems being studied by the United States Bureau of Mines that are of especial importance to the State of Washington, the Pacific Northwest, and Alaska. The investigations consist principally of laboratory work directed largely by the Bureau's technologists. The work is performed in the building known as Mines Laboratory, which has recently been doubled in size and fully equipped with the newest forms of machinery and apparatus. For the year 1929–30, the following subjects have been selected for investigation:

1. COAL

(*a*) *Utilization:* Studies of the character of coals in relation to their utilization. Coals of all ranks from lignite to anthracite occur in the state of Washington.

(*b*) *Beneficiation:* Studies of the mechanism of coal-cleaning methods and the determination of performance. The greater portion of the coal output of the state is cleaned mechanically.

2. NON-METALLICS

(*a*) *Purification:* Washing of kaolins and ochres.

(*b*) Problems in drying certain non-metallics.

(*c*) Preparation of feldspars.

Each applicant should send a copy of his collegiate record from the Registrar of the college where he graduated, or will graduate in June. He should also send a photograph and a detailed statement of his professional experience, if any, and give the names and addresses of at least three persons who are familiar with his character, training and ability. Applications should be submitted by May 1, or as soon thereafter as possible, in order to allow ample time for consideration, and should be addressed to DEAN MILNOR ROBERTS, *College of Mines, University of Washington, Seattle, Washington.*

Massachusetts Institute of Technology.

COURSES FOR TEACHERS, SUMMER SESSION 1929

Mathematics

Methods of Teaching Junior High-School Mathematics, M80. July 1 to July 30, 8.30–10.00.

Methods of Teaching Senior High-School Mathematics, M81. July 1 to July 30, 10.00–11.30.

Science

Methods of Teaching General Biology, 7.011. July 1 to July 30, 8.30–11.45.

Bacteriology, 7.301. July 1 to August 13, 9.00–12.00.

Health Education Methods, 7.603. July 1 to July 23, 1.00–3.00.

Hygiene of the School Child, 7.605. July 1 to July 23, 1.00–4.00.

Methods of Teaching General Science in Junior and Senior High Schools, G77. July 1 to July 30, 10.00–11.30.

Methods of Teaching Physics in Senior High Schools, G781. July 1 to July 30, 8.30–10.00.

Methods of Teaching Chemistry in Senior High Schools, G782. July 1 to July 30, 2.00–3.30.

General Science Laboratory, G783. July 1 to July 30, 2.00–4.00.

Education

Educational Psychology, G7. July 1 to July 30, 8.30–10.00.

Tests and Measurements in Education, G8. July 1 to July 30, 11.30–1.00.

Principles of Secondary Education, G784. July 1 to July 30, 2.00–3.30.

(*All classes are held daily except Saturday.*)

GENERAL INFORMATION

Academic Credit. The subjects listed in this announcement are accepted for credit toward the degrees of bachelor of science and master of ccience, except Bacteriology 7.301, which is credited toward the degree of bachelor of science only.

Dormitories. Separate dormitories overlooking the Charles River are reserved for women teachers.

Registration. For registration material or further information, address the Committee on Summer Session. It is desired that registration be completed in advance by mail.

Tuition and Fees. The tuition varies with the course, the minimum charge being $20.00 and the maximum $55.00. A registration fee of $5.00 is required of all students.

West Virginia University. The 31st session of the Summer School of West Virginia University, Morgantown, will be held June 7 to August 30, inclusive. A *Bulletin* containing the announcement of faculty and courses may be had upon request.

Since many of the students enrolled for the Summer Session are school superintendents, principals, and teachers, the University has planned its courses to meet the requirements of this group. The College of Education employs in the summer a considerable staff of well-trained teachers and offers a wide range of courses in education both for undergraduate and graduate students. Most of the departments of the University are open during the summer, military science and medicine being the only exceptions for the 1929 session.

The University maintains a high school which is under the direction of the College of Education. The high school affords opportunities for practice teaching and observation.

The department of education of the University conducts a teachers' employment bureau which aids in placing students and graduates of the University who are available for school positions.

All inquiries regarding the University should be addressed to Director of Admissions, West Virginia University, Morgantown, W. Va.

University of Michigan

SUMMER SESSION 1929, JUNE 24–AUGUST 16

The College of Engineering announces, for the summer of 1929, a group of new courses which are planned for teachers in technical schools and for engineers in industry. Opportunity will be given to do advanced work for higher degrees. The laboratories are open for special investigations.

Arrangements have been made not only for a selection in the purely professional subjects but also in such allied studies as advanced mechanics and mathematics. Professor Timoshenko, who is a recognized authority in the field of the application of higher mechanics to the solution of engineering problems, has consented to take charge of this latter work. A combination of his courses with some other professional subject might prove attractive.

For information address either HERBERT C. SADLER, *Dean*, or LOUIS A. HOPKINS, *Secretary*, College of Engineering, Ann Arbor, Michigan.

Brazil Summer School, Rio de Janeiro, June 29–August 27, 1929

Brazil in offering for the first time a Summer School for North Americans is giving the vacationists—whether students, teachers, internationalists or professional men—an unusual opportunity.

The Summer School Session will be under the supervision of the Brazil Research Institute, a subsidiary institution of the Instituto Historico e Geographico Brazileiro, the well-known learned society founded under the Emperor Dom Pedro II, in 1838. The leading scholars and scientists of Brazil will give the lectures, all in English, except that on tropical biology which will be in French. The morning will be devoted to lectures. Directly connected with these, in the afternoon, there will be sightseeing trips and visits. Excursions to nearby towns of interest have been arranged for Saturdays and Sundays.

The Summer Session will present five courses to any three of which members of the tour will be admitted. Should any one desire to take additional courses, a fee of ten dollars per course will be charged. The entire five courses will present sixty hours of lectures. Although the Brazil Research Institute will give a certificate for satisfactory attendance at the course, it cannot guarantee acceptance for credit of this certificate by North American universities. Students who intend to count the course for credit should make direct arrangements with their own college or university before leaving.

The courses of instruction listed are:

I. The Physical Geography and Topography of Brazil, Dr. Arrojado Lisboa, former Inspector of Northeastern Reclamation Service.

II. The Political and Social Development of the Brazilian People, Professor Backheuser of the University of Rio de Janeiro. Dr. Carneiro Leão, former Director of Public Education.

III. The Historical Evolution of Brazil from the Period of Colonization to the Present, Dr. P. Dalogras, former Secretary of State and prominent Brazilian historian.

IV. The Present Economic and Industrial Status of Brazil, Professor Delgado de Carvalho of the Collegio Pedro II.

V. Tropical Biology as Observed in Brazil (*course will be given in French*), Dr. Afranio Peixota of the University of Rio de Janeiro.

American teachers, interested in the work of primary and secondary schools, will have the assistance of the Associaçao Brasileira Educaçao in preparing a comprehensive survey of the school system.

A special tour has been organized for the convenience of those who are going to the Summer Session. Its cost, $395.00, is an exceptional value, made possible by special arrangement with the Munson Line, which is providing splendid tourist cabin accommodations. The cabins are commodious, the food and service are

excellent. Passengers will have an opportunity to use the outdoor swimming tank.

The tour will leave New York June 29th. While in Rio de Janeiro the afternoon visits will be included in the tour, but the three week-end excursions to Petropolis, Theresopolis and Nova Friburgo (all within an hour of the capital) will be extra. At the close of the Summer Session, there will be a four-day trip (expenses included), to Sao Paulo and Santos, from which latter port the tour will embark for New York, arriving August 27th.

Application blanks and further information about the Summer Session and the tour may be obtained from: Institute of International Education, 2 West 45th Street, New York, N. Y.

National Education Association

SIXTY-SEVENTH ANNUAL CONVENTION, *Atlanta, June 28–July 4, 1929*

An exhibit displaying equipment and demonstrating activities of interest to school workers is arranged as an important part of the annual convention of the National Education Association at Atlanta, June 28–July 4, 1929. The exhibit will open officially at noon on Friday, June 28th, and will continue daily from 8.00 A.M. until 6.00 P.M. on Saturday, June 29th, Monday, July 1st, Tuesday, July 2nd and Wednesday, July 3rd.

For information address the National Education Association, 1201 Sixteenth Street, N. W., Washington, D. C.

New England Association of Chemistry Teachers. The 114th Meeting of the N. E. A. C. T. was held Saturday, March 16, 1929, at Brown University, Providence, R. I.

PROGRAM

Morning Session

10.00 General Meeting Brown Teachers Association. Speakers, MRS. C. PRESCOTT, State Superintendent of Washington State University. PROFESSOR W. B. JACOBS, Brown University.

Afternoon Session

1.00 Address, "Secondary Education for All." SUPERINTENDENT REED of Bridgeport, Connecticut.

2.30 N. E. A. C. T. Meeting.
Reports of Committees.
Address, "Revised Requirements in Chemistry," MR. FRANK M. GREENLAW, High School, Newport, Rhode Island.
Address, "The Inorganic Side of Organic Chemistry." PROFESSOR KRAUS, Brown University.

Nichols Medal Award. The Nichols Medal of the New York Section of the American Chemical Society, awarded to Dr. Wm. Lloyd Evans, Chairman, Chemistry Department, The Ohio State University, was presented to him at a meeting of the section on March 1st, Dr. R. R. Renshaw presiding. Dr. Evans, receiving this honor in recognition of his achievements in studying the sugar molecule, delivered a paper on "The Mechanism of Carbohydrate Oxidation."

Award of Medal of The American Institute of Chemists. The recipients selected for the 1929 award of the medal of The American Institute of Chemists given "for noteworthy and outstanding service to the science of chemistry and the profession of chemistry in America," are Mr. and Mrs. F. P. Garvan. The presentation will be made on Saturday, May 4, 1929, at 8.15 P.M., in the Engineering Auditorium, 29 W. 39th Street, New York City. Complimentary tickets to this meeting may be obtained from Howard S. Neiman, *Secretary*, A. I. C., 2110 Woolworth Building, 233 Broadway, New York. The speakers on this occasion will be Hon. John W. Davis, Dr. John J. Abel, of Johns Hopkins, Dr. John H. Finley, of the *New York Times*, and Dr. Charles H. Herty, of The Chemical Foundation, Inc.

Symposium on General Organic Chemistry. The Third National Symposium on General Organic Chemistry will be held at Princeton University late in December, 1929. The executive committee is as follows: E. C. Franklin, *Chairman*, Stanford University; Frank C. Whitmore, *Secretary*, Northwestern University; W. L. Evans, Ohio State University; F. B. Dains, University of Kansas; J. B. Conant, Harvard University.

Seventh Colloid Symposium. The Seventh Colloid Symposium will be held in Remsen Hall, The Johns Hopkins University, June 20, 21, 22, the University being the institutional host and providing the principal speaker, Professor F. G. Donnan, of University College, London. In addition to contributions from the department of chemistry, there will be a paper by Professor Herzfeld of the department of physics. Prominent colloid chemists throughout the country will also contribute papers and Professor Frumkin of Moscow, visiting professor at the University of Wisconsin, will be present and appear on the program. Dr. Weiser of the Rice Institute is in charge of the program arrangements. The local organization for taking care of the meeting and the advertising is being formed with Professor Patrick as chairman.

Visitors may secure rooms and meals in the University Dormitory at a total cost of $6.00 for the entire meeting. In as much as the accommodations of the dormitory are limited to one hundred and fifty, early arrangements are advisable. Address all letters of inquiry to W. A. Patrick, The Johns Hopkins University, Baltimore, Maryland.

American Association of University Professors

Appointment Service

The Appointment Service authorized by the Association at the recent annual meeting is now in operation at 26 Jackson Place, N. W., Washington, D. C. Active and associate members interested for any reason in possible transfer have been invited to register. A class of junior members including graduate students and teachers of less than three years' service has been established and such members are also expected to register for possible appointment.

An appointing officer will be supplied, on application, with a list of names corresponding to his needs and with duplicates of their registration blanks, which include data as to where more complete information may be obtained. The office itself does not deal with letters of recommendation but aims to furnish carefully selected information as a basis for further correspondence between appointing officers and candidates or their sponsors.

The service will be conducted with a view to the development of mutually helpful relations with university appointment offices and national societies. Brief announcements in regard to vacancies will be published in the monthly *Bulletin*. Persons receiving appointments through the service are expected to pay a fee of three per cent of the first year's salary.

The service is maintained by the association at less than its cost as a means of facilitating the entrance of qualified men and women into the profession and of assisting those already engaged to gain deserved advancement. To appointing officers, it aims to offer a wider range of choice than can be had through existing channels.

The service will include college and university teaching and research appointments of all grades from fellowships to professorships. Opportunities for exchange and for summer teaching will be arranged so far as practicable.

Correspondence may be addressed to Appointment Service, A. A. U. P., 26 Jackson Place, N. W., Washington, D. C.

Recent Books

Enzyme Actions and Properties. ERNST WALDSCHMIDT-LEITZ, Institute Für Biochemie, Deutsche Technische Rochschule, Praga. Formerly at the University of Munich. Translated and extended by Robert P. Walton, Department of Organic Chemistry, Columbia University. John Wiley and Sons, Inc., New York City, 1929. xviii + 255 pp. 37 tables, 12 figures. 15 × 23 cm. $4.00.

According to the translator, "the work has not been attempted as an exhaustive compendium of enzyme literature but rather as a concise presentation of the fundamental principles and best accepted characteristics of enzyme action." The material within the volume is based upon the extensive research carried on in the laboratories of R. Willstätter, and constitutes a general treatment of enzyme action and properties. The original German text has been enlarged and brought up to date in translating with the coöperation of the original author, and maintaining the viewpoint of the Willstätter school.

The book is divided into a general and special section. The first section takes up the characteristics and properties of enzymes in general, dealing in separate chapters with the topics of Enzymes as Colloids, Enzymes as Electrolytes, Enzymic Kinetics, Activation and Inhibition, Enzymic Specificity and Procedures of Quantitative Determination and Preparation. The second section describes specifically a large number of representative enzymes.

As is necessary in a single volume of this size which attempts to cover in a general way the entire field of enzymes and enzyme activity many of the discussions are very brief and present a controversial aspect of the subject, without giving the evidence for or against the viewpoint put forth. However, references are given at the bottom of each page, and the work is of particular value because of the authoritative background. It is of especial interest as a presentation of the subject embodying the advanced conception of the field which has resulted from the intensive studies under the direction of R. Willstätter and the consequent discarding of worn-out theories which have served a useful purpose but are no longer tenable with the present treatment of "Enzymic Kinetics."

Students of medicine, physiology, botany and especially those of organic and biological chemistry who are working in the interesting field of enzyme activity, cannot help but be struck by the vast accumulation of literature on the subject and at the same time be confused by the many contradictory results that have been published. They will welcome this authoritative work as a reference book for establishing an outlook from which to view more detailed works on the subject.

EARL R. NORRIS

UNIVERSITY OF WASHINGTON
SEATTLE, WASHINGTON

Introductory Theoretical Chemistry. G. H. CARTLEDGE, Ph.D. Associate Professor of Chemistry, The Johns Hopkins University. Ginn and Company, Boston, Mass., 1929. xiv + 553 pp. 71 figures. 20.5 × 14 cm. $3.60.

The general plan of this book is the same as that of the same author's "Inorganic Physical Chemistry," although it is somewhat more advanced and detailed in treatment. Consequently any one familiar with the earlier work will be sure to consider this text seriously. It is well and interestingly written, is logical in development and is eminently teachable. A thoroughly logical presentation of this sub-

ject, covering such varied and interdependent phenomena, is a very difficult matter, but one feels that Dr. Cartledge has gone far in the right direction.

The reviewer must take issue with the following items. The treatment of special ionic equilibria and practical applications by themselves in Part IV seems unwise. The interest would be more sustained were they inserted with the theoretical parts they are intended to illustrate. It seems that an unnecessary amount of space is devoted to the analytical method for determining atomic weights, interesting though it may be. One has the feeling that the chapter on chemical compounds (dealing largely with atomic structure) is treated far too fully by comparison with the very brief and elementary treatment accorded such important subjects as catalysis, heterogeneous equilibrium and even the elements of thermodynamics. The relations between physical properties and chemical constitution are not discussed. Such important subjects as refractivity, optical rotatory power and absorption spectra should be accorded a little space. More problems, *with answers*, would seem desirable. There is no great wealth of literature references or suggested supplementary reading. One may question also the possibility of adhering closely to the outline of this text if laboratory work is to run in close conjunction with the lectures. The parts on atomic theory, etc., must, in the reviewer's opinion, be left until a more convenient season.

In conclusion, it is the reviewer's belief that this book will prove excellent for students of junior grade or lower, but that seniors and graduate students will, in general, require additional food.

MALCOLM M. HARING
UNIVERSITY OF MARYLAND
COLLEGE PARK, MD.

American Soap Makers Guide. I. V. STANLEY STANISLAUS, Associate Professor, Brooklyn College of Pharmacy, and P. B. Meerbott, Soap and Chemical Manufacturer and Chemist. 3rd edition. Henry Carey Baird & Co., Inc., New York, 1928. xi + 105 pp., illus. 15 × 23.5 cm. $10.00.

The authors have recognized a long-felt need for a comprehensive work on this subject, combining in one volume the modern developments in both the manufacture of soap and the chemical theories involved. They rightly stress the desirability of having such a treatise in English, written from the viewpoint of American practice, and it is their aim to present "the most complete and exhaustive book in the English language." Unfortunately, the American viewpoint is not emphasized, and small-scale European practice is often more in evidence than is American. For example, the impression is created that while steam heating is desirable, heating with direct fires is still a common practice.

While the chapter headings indicate an orderly arrangement, the text is much confused. The treatment of builders is wholly inadequate; neither their importance nor their usefulness is given sufficient space; trisodium phosphate is but casually mentioned; sodium silicate is treated as a stoichiometric chemical compound without reference to the Na_2O SiO_2 ratio. The critical spirit is not in evidence. Thus the chapter on "Modern Views on Soap" gives a haphazard conglomeration of quotations from numerous writers, often contradictory, often out-of-date, and even when modern work is referred to, the treatment is so abbreviated as to be of little value. Some degree of superficiality is, perhaps, to be expected, but why have a chapter on "Candles," for example, if it must be condensed to ten pages.

It is possible that the book may prove of value to the small-scale soap-maker who ladles his soap into barrels and crutches by hand. It can be of little help to others, but after all, may not the blame lie with the soap manufacturers themselves who keep their own advances secret? The book cannot be recommended as throwing light upon the theoretical chemistry of the soap industry, and it is not reliable in its descriptions of mod-

ern plant practice. The text abounds in errors which must be attributed to the original manuscript rather than to inadequate proofreading. In English composition it is very poor.

WALTER C. PRESTON

THE PROCTER & GAMBLE CO.
IVORYDALE, OHIO

A Textbook of Organic Chemistry. JOSEPH S. CHAMBERLAIN, Ph.D., Professor of Organic Chemistry, Massachusetts Agricultural College. Second edition revised. P. Blakiston's Son & Co., 1012 Walnut Street, Philadelphia, Penna., 1928. xxx + 901 pp. 22 × 15 cm. $4.00.

The first edition of this book appeared in 1921. In the present edition there are two new features: "A list of study questions and problems at the end of each chapter, and references to laboratory preparations cited in Appendix II, p. 847," for substances described in the text. The book is an excellent one for the beginner, as the author has been lavish in the use of graphical formulas and tables, and the explanations are in general good. The table of contents gives a real picture of the material covered in the book, taking up as it does some thirty pages. There is considerable evidence of re-writing and revision throughout, and nearly all for the better. The list of references for the laboratory has been verified and represents a good selection of laboratory experiments. The study questions are well chosen and free from ambiguity; they will serve as an excellent means of verifying the student's mastery of the subject matter.

Some teachers of organic chemistry may not approve of the order in which the various groups are taken up, the alcohols being considered only after the amines, phosphines, arsines, nitrites, nitro compounds, and metallic derivatives. The reviewer does not feel that this order is a particularly desirable one. The chapters on proteins and carbohydrates are well presented and interesting. Especially commendable is the chapter on diazo compounds.

Some of the omissions and errors, on the other hand, are rather surprising. There is no particular advantage evident in the mention of certain clinical laboratory tests in a book of this kind especially when the methods given are rather out of date. This applies in particular to the old Folin-Shaffer method for uric acid (page 420), and the Doremus method for urea (both page 408). Neither of these methods is in wide use at present, the methods of Benedict and Franks, or Folin and Wu for uric acid and the various modifications or the urease method for urea having been in use for some years. The Hopkins-Cole reaction does not "show the presence of protein" (page 397), but only those proteins which contain the tryptophane group. It would have been better to discuss the lactam-lactim forms of uric acid with the main discussion of that substance (page 416), instead of leaving this important phenomenon until the end of the book (page 819).

The book has no formal presentation of the history of organic chemistry but there is plenty of information of this kind dispersed throughout the text with the discussion of historically interesting compounds, and the great names in the development of organic chemistry have not been neglected. No mention is made of the Cannizarro reaction by name, and the reaction is shown only for benzaldehyde. In the discussion of the aldol reaction no explanation of the mechanism is given, no mention of labile hydrogen which is decidedly helpful to the student in understanding the large number of reactions that can be treated in the same category. It is stated (page 609) that "benzaldehyde in its general reactions is like all aldehydes." It is, accordingly, no wonder that students are surprised to find that benzaldehyde does not reduce Fehling's solution. In the opinion of the reviewer, the subject of stereochemistry is given inadequate treatment.

The Thiele theory of partial valences is not mentioned, nor is the Crum-Brown rule to be found in the index as such. As described in page 475, the student is required to memorize two lists of radicals. The general and equally reliable Vorlander modification of Crum-Brown's rule has been also omitted. In view of the present wide use of the quinhydrone electrode and the Clarke and Lubs series of substituted sulfone phthaleins as indicators, the reviewer would like to have seen these substances included in a book as comprehensive as this one, rather than some of the less important compounds mentioned.

The book is well printed on good paper. The author and publishers are to be congratulated on the excellence of the proofreading as the book is remarkably free from typographical errors.

Despite the faults found the reviewer enjoyed reading the book and he has no hesitation in recommending it as a teachable text sure to be of value to both students and teachers of organic chemistry.

L. C. MACTAVISH

NEW YORK UNIVERSITY
WASHINGTON SQUARE COLLEGE
NEW YORK CITY

Blood and Urine Chemistry. R. B. H. GRADWOHL, M.D., Director of the Gradwohl Laboratories, St. Louis, Mo. and I. E. Gradwohl, A.B., Instructor in the Gradwohl School of Laboratory Technic, St. Louis, Mo. C. V. Mosby Company, 3523–25 Pine Blvd., St. Louis, Mo., 1928. 542 pp. 117 illustrations and 4 color plates. 17 × 25¼ cm. $10.00.

The first sentence of the preface, to the effect that the work is a textbook for laboratory workers and practitioners of medicine, invites the statement of opinion that a physician with only the usual training in chemistry should not assume the duties and responsibilities of a biological chemist, even with the help of a technician.

The chapters on the installation and equipment of the laboratory, and description, care, and use of instruments are excellent, and the illustrations well chosen. The descriptions of methods of analysis are concise, clear, and devoid of unnecessary verbiage. If followed rigorously, and with the necessary skill, dependable results will ensue. Certain modifications in technic which have met favor are omitted, but that is a matter of author's judgment and user's choice. The careful inclusion of calculation formulas will be very welcome to those not sufficiently accustomed to the arithmetical manipulation of analytical data. In a book so replete with data and tables, it is excusable that some errors should appear and even statements that the author on further consideration would modify.

From a chemical standpoint, the theoretical chapters do not assume on the part of the reader much mastery of fundamental science, without which any discussion of physiological and pathological processes must be incomplete. Many of his readers, not thus equipped, will rejoice at this, and will be satisfied with the general theories and facts presented. Where opinions in interpretation differ, the presentation is fair and reference to literature generous. Inspiration to further reading and deeper study should result.

C. E. BOLSER

DARTMOUTH COLLEGE
HANOVER, N. H.

The A B C of Hydrogen Ion Control. W. A. TAYLOR, Ph.D., Chemical Director. The LaMotte Chemical Products Co., Baltimore, Md. Fifth Edition, 1929. 132 pp. 18.5 × 26.5 cm. Illustrated. Free.

The fifth and enlarged edition of this booklet is in line with the steadily increasing numbers of practical applications of hydrogen-ion measurements to the various types of research and industrial work. The material presented is divided into five main portions: The Meaning of Hydrogen-Ion Concentration, including

a discussion of the meaning of the pH scale and of pH values, and methods of making determinations (pp. 7–24); Applications (25–78); Materials and Equipment (79–112); Special Chemicals (113–114); Materials and Equipment for Water, Sewage and Industrial Waste Analysis (115–131).

Some of the new sets which have been added in this edition are:

	Page
Dalite Comparator Lamp	88
Sludge Testing Set	116
B. O. D. Set	118
Sterilization Test Set	123
Permanent Standards for Water, Sewage and Industrial Wastes Analysis in sealed Nessler Tubes with polished tops and bottoms	125
New Colorimeter for Nessler Tube Comparison	128

For those who possess an earlier edition of this booklet, this fifth edition will be a necessity. Any one interested in the subject of hydrogen-ion control will find a vast store of information between its covers. M. W. G.

Popular Science Talks, 1927-1928. Presented by Members of the Faculty of the Philadelphia College of Pharmacy and Science and published under the auspices of the *American Journal of Pharmacy*. I. GRIFFITH, Editor. Vol. VI. Phila. Coll. Pharm. & Sci., 1929. 249 pp. 15 × 23 cm. $1.00.

The contents listed below indicate the scope of these talks.

1. The Romance of Cookery. C. H. La Wall
2. The Heart. A. Viehoever
3. The Realm of the X-Ray. I. Griffith
4. Building Stones. J. Sturmer
5. The Preservation of Foods. L. Gershenfeld
6. What and Where Are the Stars? G. Rosengarten
7. Sumac and Poison Ivy. H. C. Wood
8. Ice—Wet and Dry. P. Q. Card
9. The Rare Elements. F. P. Stroup
10. European Flowers in Commerce and Culture. E. F. Cook
11. Flame. G. W. Perkins
12. Animals That Live in Man. M. S. Dunn.

M. W. G.

Youth and the Good. School Betterment Studies. Vol. 1. No. 2. HENRY C. FRICK, Educational Commission, Pittsburgh, Pa., 1929. 76 pp. 12.5 × 18 cm. Free.

This book is the second of the publications of the Henry C. Frick Educational Commission. It is a report of a recent experiment in introducing a group of outstanding humanitarians direct to high-school pupils; the comments of the pupils; and the effort to make the assembly program the beating heart of the high-school organization.

M. W. G.

Funds Available in the United States for the Support and Encouragement of Research in Science and Its Technologies. C. HULL AND C. J. WEST, Compilers. *Bulletin of the National Research Council*, No. 66. Second Edition. Published by The Nat. Res. Council of the Nat. Acad. of Sciences, Washington, D. C., 1928. 90 pp. 17 × 24.5 cm. $1.00.

The Scope of the Bulletin. The phrase "Funds for Research" has been used to cover all funds which are used for the purpose of actual research, but as far as possible funds available only for administrative purposes have been omitted. Hence, the information here presented concerns funds available for the encouragement and support of research in the form of medals, prizes, grants, or institutional funds.

"It is hoped that the publication will be at least a helpful and suggestive contribution to those interested in the status of scientific research in the United States."

M. W. G.

Statistics of Education of the Negro Race, 1925–1926. *Department of the Interior*. No. 19. D. T. BLOSE, Principal Statistical Asst. U. S. Govt. Printing Office, Washington, D. C., 1929. 42 pp. 14.5 × 23 cm. $0.10.

Laws Relating to Compulsory Education. *Department of the Interior*, No. 20. W. W. KEESECHER, Asst. Specialist in School Legislation. U. S. Govt. Printing Office, Washington, D. C., 1929. 70 pp. 14.5 × 23 cm. $0.15.

Secondary Schools of the Southern Association. *Department of the Interior*, No. 16. J. ROEMER, Professor of Secondary Education and High-School Visitor, Univ. of Florida. Secy. to the commission on secondary schools of the Assoc. of Colleges and Sec. Schools of the Southern States. U. S. Govt. Printing Office, Washington, D. C., 1928. 92 pp. 14.5 × 23 cm. $0.20.

BOOKS RECEIVED—LIBRARY OF CONGRESS, FEBRUARY 15 TO MARCH 15, 1929

Beale, Harriet Stanwood, The beginnings of chemistry; a story book of science for young people. New York, Coward-McCann, Inc., 1929. ix pp., 1 l., 243 pp., illus., diagrs. 19½ cm.

Belcher, James Elmer, and J. C. Colbert, Identification and properties of the common metals and non-metals. (The Century chemistry series; J. Kendall, editor.) New York, London, The Century Co., 1929. 246 pp., illus. 27½ cm.

Berry, Thomas Morris, The alkylation of benzene, toluene and naphthalene. Easton, Pa., Mack Printing Company, 1928. 10 pp. 23½ cm. Thesis (PH.D.) —Johns Hopkins University, 1923.

Bullock, Edmund Rayner, Chemical reactions of the photographic latent image. New York City, D. Van Nostrand Company, Rochester, N. Y. v. illus., diagrs. 22 cm.

Burgess, Wayland McColley, A study of the properties of the system lithium chlorate–water. I. Introduction. II. Phase relations. Easton, Pa., 1927. 12 pp., illus., diagr. 23½ cm. Thesis (PH. D.)—Brown University, 1925.

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Cartledge, Groves Howard, Introductory theoretical chemistry. Boston, New York, Ginn & Company, 1929. xiv, 553 pp., illus., diagrs. 21½ cm.

Cook, Robert Graham, The principle of the specific interaction of the ions in mixtures of high valence electrolytes. New York City, 1928. 31 pp., diagr. 23 cm. Thesis (PH.D.)—Columbia University, 1928.

Craveri, Calisto, Dizionario di sinonimi e composti chimici con relative formole e pesi molecolari e le terminologie; chimica —farmaceutica—alchemistica. Milano, U. Hoepli, 1928. vi, 316 pp. 23½ cm.

Davis, Herbert Leroy, Osmotic pressures of concentrated solutions. Ithaca, N. Y., 1928. 43 pp. 26½ cm. Thesis (PH.D.) —Cornell University, 1927.

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tions. Chicago, The Eclectic Publishers, 1929. 269 pp. 17 cm.

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9, (1) p. 23½ cm. Abstract of thesis (PH.D.)—University of Illinois, 1928.

Sherwood, George Ray, Observations on the rare earths: studies in basicity. Urbana, Ill., 1929. 6 pp. 23½ cm. Abstract of thesis (PH.D.)—University of Illinois, 1929.

Skidmore, William Ralph, Some reactions of sulfur and its oxides. Iowa City, 1928. 18 pp., 1 illus. 23½ cm. Thesis (PH.D.)—University of Iowa, 1925.

Strouse, George Clifford, The mechanism of carbohydrate oxidation; the oxidation of glucose by copper acetate. Columbus, 1928. 24 pp., diagrs. 24½ cm. Thesis (PH.D.)—Ohio State University, 1927.

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Zimmermann, Albrecht, Die botanische mikrotechnik. Ein handbuch der mikroskopischen präparations-, reaktions- und tinktionsmethoden. Tübingen, H. Laupp, 1892. x, 278 pp., illus. 23 cm.

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Breslau. Schlesisches kohlenforschungsinstitut, Mitteilungen aus dem Schlesischen kohlenforschungsinstitut der Kaiser-Wilhelm-gesellschaft in Breslau. Editor: Fritz Hofmann. Berlin, Gebrüder Borntraeger, 1922. v. illus., plates. 24½ cm.

Chemical and Metallurgical Engineering, Modernizing for profits in chemical engineering industries. A symposium. New York, N. Y., 1929. 145 pp., illus., diagrs. 23½ cm.

New York. College of the City of New York, Chemistry, College of the City of New York science survey. Lancaster, Pa., Lancaster Press, Inc., 1929. iv, 66 pp., diagrs. 23 cm.

Nitrogen Called Robber of Blast Furnace Heat. The usually inert nitrogen of the air was called a thief of heat and a destroyer of the efficiency of the blast furnaces that produce the iron of the world's commerce in a theoretical discussion by Richard Franchot, consulting chemist of Washington, D. C., before the recent meeting of the American Institute of Mining and Metallurgical Engineers in New York.

Nitrogen when combined with other elements is a valuable fertilizer and basic chemical, but when a free gas, as it is in the air around us, it is plentiful but useless. Chile nitrates are the sole natural supply of fixed or combined nitrogen, and to make other nations independent of the basic chemical, various methods of "fixing" the nitrogen of the air have been developed in the last two decades. A similar fixation of nitrogen takes place in the blast furnace where it is not wanted, Mr. Franchot believes, and the damaging result is that 40 to 50% of the heat energy applied to the smelting of the iron ore is absorbed by the chemical reaction involved in the accidental fixation of some of the nitrogen that enters the furnace along with the air oxygen necessary for combustion.—*Science Service*